

NATURAL HISTORY OF MAMMALS.

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Vulpes vulpes, fox.

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NATURAL HISTORY OF MAMMALS.

CLASS X.—MAMMALIA.

IN the beginning of the third volume of this series we have a general account of the anatomy and physiology of the branch of Vertebrata; and here, as an introduction to the class of Mammals, we need only to refer very briefly to some of the special diagnostic characters which separate this group from the other divisions of backboneed animals. In this account we have intentionally omitted those features which are common to all vertebrates, and all description of physiological phenomena which, as explained in the ordinary school text-books of human physiology, will apply as well to the whole class of mammals as to man.

The Mammalia, the highest class of the animal kingdom, is more distinctly marked off from all other groups than are many of the classes considered in the preceding volumes. While there frequently exists a doubt as to the proper boundaries of some of the lower groups, or their relative importance in the scale of perfection, no such hesitancy is felt regarding the limits or the grade of the mammalia. Even within the limits of the class the orders are all well defined, and in most cases their relative rank is pretty well settled. This superiority of the mammalia over all other classes of the animal kingdom does not imply that every organ is more perfect or better adapted to its purpose, or that every individual is really higher; but that when we come to regard the totality of the organization, and the setting apart of portions of the body for some specific purpose, resulting in an increased differentiation of organs and an increased complexity of the organism, upon which alone the relative rank of animal rests, the higher rank is at once evident. Thus the human eye, far from being the perfect organ described in some works of a teleological tendency, is less perfect than that of the eagle in many respects, and yet no one would think on this account of placing the bird of prey higher than man.

Like all vertebrates, the mammals never have more than two pairs of limbs, but with the exception of some of the aquatic forms (whale, etc.), these two pairs are always present, whence the name in frequent use for the class—quadrupeds. The anterior pair of limbs are never absent in the group. Except in a few forms, to be noted below, the body is covered with hair. The mouth is usually armed with teeth. The heart is four-chambered, and the circulation is complete. The blood is warm and contains non-nucleated red corpuscles. The body cavity is divided into two portions by a transverse muscle, the diaphragm, or “midriff,” the anterior portion being called the pleural, and the posterior, or abdominal portion, the peritoneal cavity. The young are born alive, and are afterward nourished by milk, secreted by milk-glands (*mammæ*), whence the name of the class.

In size the Mammalia vary from the tiny harvest-mouse of Europe, which weighs scarcely more than an old-fashioned copper cent, to the whales, which are said to sometimes reach the neighborhood of a hundred feet in length, the largest representatives of the animal kingdom now alive.

Turning now to some of the details of structure, we have to note that the hair, which is found alone in mammals, occurs upon at least a portion of the body in every member of the group. In the young whales hairs are found in various parts, but in the adult they have entirely disappeared, with the exception of a few bristles near the mouth of some forms. Hairs are to be regarded as epidermal structures. Each hair is a solid body without nerves or blood-vessels, and increases in size from the root. To the microscopist, hairs (especially those of bats) have been of great interest from the peculiar ornamentations which they exhibit, the cells of which they are formed frequently forming prominent whorls of scales or spines around the body. It is by the interlocking of these scales that hairs can be "felted." Wool possesses this property to a marked degree. Some hairs, as for example the whiskers, or vibrissæ, of cats, are connected at their base with branches of the fifth pair of cerebral nerves, thus constituting them organs of touch; a feature to which we shall recur in connection with that sense. In the porcupine, hedgehog, spiny ant-eater, etc., some of the hairs become greatly enlarged, forming spines which, being moved by appropriate muscles, can be elevated so as to produce a most effective defensive armor. These same muscles occur, although less highly developed, in the whole of the mammalia, enabling the dog to raise the hairs along the middle of the back, and the cat which he chases to greatly increase the apparent size of her tail. A still further modification of hair appears in the horns of some ruminants, as the cow, where the outer surface, the horn of commerce, is usually regarded as consolidated hair. The horn of the rhinoceros partakes of the same character, while in the armadillos the hair unites with the plates of bone developed in the skin, forming a solid investment for the upper portion of the body. The claws and hoofs of the Mammalia are also usually regarded as morphological differentiations of hair, but there seem to be strong objections to this view.

In their osseous system mammals are well marked off from all other vertebrates. The bones contain a large proportion of salts of lime, and hence possess a greater rigidity than is usually the case in the other classes. The skull articulates with the first bone (*atlas*) of the vertebral column by two rounded prominences (occipital condyles), one on each side of the large opening (*foramen magnum*). In the Batrachia alone do we find a similar structure, but even here a very important distinction arises. In the Batrachia these condyles are formed by the *exoccipitals alone*, in the Mammalia the *basioccipital* enters into their composition. The bones of the face are immovably united with each other, although here, as in the rest of the skull, the sutures usually remain distinct throughout life, though sometimes they become obliterated in the adult, especially late in life. Although arising from several centres, each half of the lower jaw consists of but a single bone, and articulates directly with the skull, without the intervention of the quadrate bone, which, when present, occupies this position in the lower group of vertebrates, but which in the mammals forms one (*malleus*) of the chain of small bones of the ear. In most mammals the superior maxillaries are more elongate than in man, and the inter-maxillaries usually remain distinct. The cavity of the skull, as in birds, is completely occupied by the brain, and is more or less distinctly divided into three portions for the reception of the corresponding divisions of the brain, and in some instances the boundaries between the cerebral and cerebellar cavities are

emphasized by the development of a transverse membranous or bony process, the tentorium. In the mammals alone, and here but occasionally, does the squamous portion of the temporal bone form a portion of the enclosing wall of the cranial cavity.

The vertebral column presents but few points of popular interest. The body of each vertebra is generally flat on the articular surfaces, though in some groups (*e. g.*, some Ungulata) the anterior surface is convex, the posterior concave. Between the vertebræ are placed elastic cushions, intervertebral cartilages, which give the column its flexibility and in man protects the brain from the jar of walking.

The column can be generally divided into five more or less distinct portions: cervical, dorsal, lumbar, sacral, and caudal, corresponding respectively to the neck, back, "small of the back," pelvis, and tail. The total number of vertebræ varies greatly. Some of the bats have but twenty-six, *Hyrax* and *Choloepus* forty, while the long-tailed *Manis* of Africa has forty-six in the tail alone. The number of cervicals is very constantly seven, the only exceptions which occur to the writer being six in the Manatees, and one species of *Choloepus*, and nine in the three-toed sloths. From this it will be seen that the length of neck does not depend upon the number of the bones; the giraffe, whose neck is three-sevenths of that of the entire body, having exactly the same number of cervical vertebræ as man, where the neck is proportionally but a third as long. In most mammals the cervicals are all free, but in the whales every gradation can be found from the narwal and fin-back whales, where all are free, to *Balaena* and *Hyperodon*, where sometimes they are all coalesced.

In the remaining divisions of the vertebral column the number of elements is very irregular, the dorsal and lumbar together showing a variation between fourteen in the Armadillos to thirty in *Hyrax*, and even in the same genus a large difference is sometimes found. In the sacral and caudal portions this irregularity is increased.

The ribs, which are movably articulated with the dorsal vertebræ, usually differ from those of birds, in that the portions which are connected with the breast-bone (sternum) remain cartilaginous throughout life, ossification occurring here in but a few forms. Except in the monotremes, the shoulder-girdle differs from that of reptiles and birds in the extremely rudimentary condition of the coracoid, which occurs only as a process of the scapula. The clavicle is not always present, for it is not found in the Cetacea, Ungulata, and some edentates, while it exists only in a rudimentary form in the carnivores and some rodents. The episternum is present only in the monotremes.

The anterior limbs are never absent, and here we find the same divisions which we have found in other groups. Upper arm (*humerus*), forearm (*radius* and *ulna*), wrist (*carpus*), palm (*metacarpus*), and fingers (*phalanges*). The humerus presents no striking peculiarities, but as we proceed outward from the body the amount of variation increases. In forms where the radius and ulna are free, as in man, there is usually more or less power to rotate the hand; but when united, as in the ungulates, this capacity for rotation is lost, while together with this union of the bones of the forearm, it is frequently found that the ulna shows a more or less marked tendency toward obsolescence, as is well exemplified in the horse and among the bats. The carpus is composed of from five to eight small bones: in the feet the variations become so extensive, both as to form and number, as to be in some instances only of generic importance, and hence need not be mentioned here.

The posterior limbs are wanting in the whales and Sirenia alone, and here their abortion has extended so far that the pelvis itself has almost entirely disappeared, it being represented by a pair of small bones embedded in the muscles and not otherwise

connected with the skeleton, and concerning whose homologies anatomists are yet uncertain. In the seals, where the hinder limbs form a sort of fin or paddle, this degeneration of limbs and skeleton has proceeded not quite so far, for the femur or thigh-bone (which here is almost entirely formed of the two articular surfaces, the shaft being greatly reduced in length) shows the greatest deviation from the normal type, while the other and more distal bones are not so greatly modified. Details will be found under the various orders.

In their reproduction mammals show many important points of difference from all other groups of the animal kingdom. Among the other forms there are many cases where the young is brought forth alive, but in these instances the egg merely undergoes its development inside the parent without any very intimate connection existing between the two; while in the Mammalia, the young as long as retained within the parent receives nourishment from her, and after birth the mother continues to feed the progeny with milk from peculiar glands called *mammæ*, whence the name of the class Mammalia. The young are, in the different orders, born in different stages of development; in the marsupials the young are very helpless and very imperfect, while in the cow and horse they are able to run alone and to suckle; between these two extremes various intermediate phases may be found.

As has just been stated, the Mammalia pass through a portion of their development while inside the mother, receiving nourishment from her. In all, except the monotremes and marsupials, a placenta is formed by a union of the allantois with the membranes of the uterus, and through this placenta the nourishment is conveyed to the embryo. This subject is, however, better adapted for treatment in more technical works, and with this slight mention we dismiss it here.

From a systematic standpoint the teeth are very important organs in the structure of the mammals, for their variations are usually of such a well-defined character that they may be used as foundations of schemes of classification, and afford valid characters for the separation not only of species and genera, but of higher groups as well. The teeth in most forms are divided into four groups. Following the grouping derived from human anatomy we will give the characters of those in the upper jaw, those of the lower corresponding in name according to their relative position: 1st, incisors, the teeth with usually sharp-cutting edges and simple roots, implanted in the intermaxillary bone in the centre of the jaw; 2d, the canines, situated in the maxillary bone just behind the intermaxillary suture; 3d, the molars, which in turn are divided into two groups—the premolars or molars which replace the temporary molars, and the true molars which do not replace temporary teeth. With this classification it is an easy matter to express in figures the number of teeth in any animal without unnecessary repetition by means of a “dental formula.” In this the teeth are represented in the form of fractions, those of the upper jaw forming the numerator, those of the lower the denominator. Thus the milk dentition of a child would be written $i \frac{2-2}{2-2}, c \frac{1-1}{1-1}, p \frac{2-2}{2-2}, m \frac{0-0}{0-0} = 20$, showing that there are two incisors, one canine and two premolars in each side of each jaw, while the molars are absent. The permanent dentition of man would be the same, except that the molars would read $m. \frac{3-3}{3-3}$. The dental formula of the kangaroo is $i \frac{3-3}{1-1}, c \frac{0-0}{0-0}, p \frac{1-1}{1-1}, m \frac{4-4}{4-4} = 28$; showing that there are three incisors on each side in the upper jaw and but one in the lower. The canines are absent, while there are one premolar and four molars in either side of each jaw. For

convenience, it is customary to represent but one-half of each jaw in the formula, so that that of the kangaroo usually appears as $i \frac{3}{11}, c \frac{0}{0}, p \frac{1}{1}, m \frac{4}{4}$. The teeth are to be regarded as partly epidermal, the enamel being formed from that layer, while the cement and dentine grow from the true derm. At an early stage a slight groove is formed in the surface of the jaw, gradually deepens, and finally the margins unite, leaving a cavity entirely enclosed by the skin. The lining of this cavity, which from its mode of origin we know to be epidermal, produces the enamel of the tooth, and at the same time a papilla of the true skin is forming the bulk of the tooth. In cases where milk as well as permanent teeth are developed a second pocket grows out from the first, finally separates, and there forms the permanent tooth. In the monotremes, edentates, and Cetacea but a single set of teeth are formed—all others in which teeth occur have two sets.

The dental variations of a few mammals may here be noticed. In the ant-eater no teeth are found, while the duck-bill has only horny plates. Incisors are lacking in the sloths and canines in the rodents. In the whales (except in the fossil group of Zeuglodontia) the teeth when present never have more than a single root, and in the whalebone whales the teeth are absorbed before birth. In the male narwal one of the canines (left) acquires an enormous development, sometimes eight feet in length. In the elephants, the upper incisors form the tusks, those of the lower jaw not being developed.

The alimentary tract of the mammals consists of the mouth, with its teeth, œsophagus, stomach, and the small and large intestines. With them may be also considered the various accessory organs of digestion; the liver, gall-bladder, and pancreas. Salivary glands are present, except in the Denticete whales. In most mammals the stomach is simple, as in man, but in many rodents, in the upper portion, there is a large accumulation of glands. In the kangaroo, and in *Pteropus* and *Semiopithicus* the stomach is elongate, and resembles a part of the large intestine, and in the last-mentioned form it is divided into three chambers, a structure which has a somewhat similar exemplification in the sloths and toothed whales, and which suggests to us the compound stomachs of the ruminants, which will be discussed at length in connection with the order of ungulates in a later portion of this volume. The intestine is usually longer in the mammals than in the other vertebrates, and among this class it acquires the greatest development in length in the herbivorous forms. The small intestines are lined (except in a few forms) with longitudinal villi, thus increasing the absorptive surface. At the junction of the small and large intestine, a blind prolongation (*cæcum*) is usually found. In *Myrmecophaga didactyla* there are two of these cæca, but in the closely allied *M. jubata*, no such diverticula are found. At the extremity of the rectum there is developed in many carnivores (badger, hyena, and the familiar skunk), and some few other forms, a number of glands which secrete a highly odorous fluid. In all the mammals, except the Ornithodelphia, the genital and intestinal openings are separate, but in the latter sub-class they open into a cloaca, as in birds.

The liver is as a rule more divided into lobes among the carnivores than among the vegetable-feeders. The gall-bladder is wanting among a large number of mammals, being absent among many rodents, some ruminants, the toothed whales, the elephant, horse, etc. In the dolphins the spleen is divided into several small distinct masses (sometimes as many as eighteen). The intestine is supported by the mesentery, and in this mesentery, in mammals alone, are found lymphatic glands. The general physiology of the digestive system of mammals may be learned from any text-book of human physiology, the differences between the various forms being very slight.

In the organs of circulation we see a general similarity to those of birds. The heart is four-chambered, and is invested with a pericardium. In its shape it shows considerable variation, being broad in the Cetacea and Proboscidea, elongate in the dog, round in most monkeys, or conical in the horse, ox, orangutan, and man. In fœtal life the two auricles communicate with each other by an opening in the wall between them, the foramen ovale. In adults this aperture is usually closed after birth, but in the seals, and other forms leading an aquatic life, it sometimes remains open. The two auricles are situated above, the two ventricles below, and for sake of distinction, the terms right and left are applied to each. Each auricle communicates with the ventricle of the same side, the opening being provided with valves, which allows the blood to pass in but one direction—from the auricle to the ventricle. The *venæ cavæ* terminate in the right auricle, the pulmonary vein in the left auricle, while from the right ventricle arises the pulmonary artery, and from the left the great artery (the aorta) of the body. The details of the circulation do not properly belong here, and so only a few general statements are made. The blood, which is poured into the right auricle from the system by means of the *venæ cavæ*, passes thence to the ventricle of the same side, which forces it through the lungs. In these organs the blood is exposed to the influence of the oxygen of the air, giving off carbonic oxide, and then, by means of the pulmonary vein, it passes back to the left auricle, thence to the left ventricle and through the aorta, and the arteries which arise from it, passes into the general circulation, to be again gathered up, after passing through capillaries, by the veins, and conducted to the two large venous trunks, the superior and inferior *venæ cavæ*, and thence to the right auricle. Beyond these points the general features of the mammalian circulation need not here be discussed, as the account given in most text-books of human anatomy or physiology will apply, in a general way, to the whole group of mammals, while an account of the variations from that type falls within the province of the technical manuals of comparative anatomy. Some of the principal diagnostic points which separate the mammals from the other vertebrates may, however, be mentioned. In their circulation mammals differ from all vertebrates, except birds, in having a four-chambered heart and a complete circulation; that is, all the impure blood which is received by the heart is sent to the lungs for purification, and only oxygenized blood goes into the general circulation. From the birds we notice a difference in the fact that the left instead of the right aortic branch of the fœtus persists as the aorta in adult life, and that in most mammals (except the duck-bill, elephant, and most rodents) there exists but one superior vena cava.

In most of the Mammalia (except the camels, lama, etc.), the red, non-nucleated blood corpuscles are almost perfectly circular in outline. The size is quite variable, as will be seen from the following examples taken from Dr. Gulliver's measurements:—

Musk deer,	$1\frac{1}{2000}$	of an inch.	Ox,	$\frac{1}{4200}$	of an inch.
Red deer,	$\frac{1}{5000}$	"	Dog,	$\frac{1}{3500}$	"
Goat,	$\frac{1}{8300}$	"	Man,	$\frac{1}{3000}$ - $\frac{1}{4000}$	"
Sheep,	$\frac{1}{5300}$	"	Elephant,	$\frac{1}{2700}$	"
Horse,	$\frac{1}{4600}$	"	Two-toed sloth,	$\frac{1}{2800}$	"
Cat,	$\frac{1}{4400}$	"	Wolf,	$\frac{1}{3600}$	"

In criminal trials the microscopic appearance of blood-stains and blood-clots are frequently of great importance, but evidence of this character should be very cautiously accepted; for while it may be possible to state with certainty that a stain is not pro-

duced by the blood of birds or sheep, still one cannot say with absolute certainty that it is produced by human blood. The size of the corpuscles is the feature given most weight, but while a diameter of one three-thousandth of an inch is most usual in man, smaller corpuscles, sometimes reaching to the other extreme given above, are not infrequently seen.

Among the respiratory portions of the anatomy we may enumerate the trachea, bronchial tubes, and the lungs. The trachea (considering the larynx but a modified portion of it) arises at the lower end of the pharynx, just before the beginning of the œsophagus, and passes down in front of that canal until the pleural cavity is reached, where it divides into two or (in Ruminantia, dolphins, and a few other forms) three bronchi, which are distributed to the two lobes of the lungs. The trachea and bronchi are formed of a series of rings of cartilage placed one after the other, and in order to economize room, the posterior portions of the tracheal rings are membranous, so that when food is passing down, the œsophagus the necessary enlargement of that canal is obtained by the pressing in of the soft portion of the trachea. In a few forms (*e. g.* the dolphins) the rings are more perfect, while it is stated that in the whales the anterior portion of the trachea is membranous. This difference may be noted between the trachea of mammals and birds, that in the latter the organs of sound are situated at the lower end of the tube; in the former, at the upper, in a specialized portion called the larynx, which throughout the whole of mammalia exhibits much the same structure as in man.

Each bronchus is divided up, usually dichotomously, into a number of bronchial tubes, in connection with the extremities of which are the terminal cells of the lungs. In all mammals there are two lungs which usually are divided into a varying number of lobes. In the mechanism of breathing a structure occurs which is usually regarded as peculiar to mammals, though in reality traces of it are found in some birds. The body cavity in this group is divided into two portions by a nearly horizontal muscle. In the upper (the pleural cavity) are found the heart and lungs, in the lower (peritoneal) cavity occur the organs of digestion. This muscular partition, which is perforated for the passage of the œsophagus and blood-vessels, is called the diaphragm. When this muscle contracts it recedes, increasing the cavity of the thorax, and thus the air is drawn into the lungs. This act of inspiration is also aided, as in birds, by the ribs, which are moved chiefly by the intercostal muscles, but the perfect diaphragm is found in mammals alone.

It is in the development of the nervous system that the mammals are especially seen to be the highest group of the Vertebrata, and this development shows itself as much in the extent to which it is carried as in the methods of execution. The brain is distinguished from that of all other vertebrates by a commissure (*Pons varolii*) uniting the hemispheres of the cerebellum, while the cerebral hemispheres are connected to a greater or less extent by an anterior commissure and a superior transverse commissure, the *corpus callosum*. These two cerebral commissures are developed in nearly an inverse ratio; in the Monodelphia the corpus callosum is well developed, the anterior commissure being small; in the placental forms these relations are reversed, the anterior commissure being large, the corpus callosum rudimentary. The cerebrum is by far the larger portion of the brain, and in the highest forms completely covers the cerebellum as it lies in the cavity of the skull. In most mammals the cerebrum is more or less convoluted, and as the convolutions increase in complexity so increases the relative rank of the animal. In recent times many

observations have been made upon these convolutions in an endeavor to localize the various impulses of the mind, and although the results (mostly obtained from dogs) are as yet very fragmentary, they are highly interesting and instructive. The discussion of these results would be out of place here, but we may note, in passing, that they do not show the slightest accord with the now thoroughly exploded theories of phrenology. In the lower forms we find that the whole of the spinal cord functionates to a certain extent as a brain, but with the higher rank we find the brain more and more specialized, and consequently increased in size. Geology tells us the same story. In the eocene mammals the cerebral lobes of the brain were scarcely larger than the beginning of the spinal cord; in the dog of the present day it is twice, and in man seven times as broad as the cord. The nerves of the Mammalia correspond in a general way with those of man, though of course, with the varying number of vertebræ, we find a corresponding difference in the number of spinal nerves. The phrænic nerves, which arise principally from the fourth pair of cervical nerves, and supply the diaphragm, are peculiar to mammals.

As a rule the senses acquire their highest development in the Mammalia. The sense of touch exists in almost all parts of the surface of the body, except in the epidermal structures, hair, nails, horns, etc., but acquires very different developments in different portions. The relative sensibilities and capacity for distinguishing between different impressions which exist in various portions of the human body have been tested by a very simple but ingenious experiment. The points of a pair of dividers were placed on various portions, and the least distance noted at which distinct sensations were experienced at the same time from each point. From this it was learned that the tip of the tongue is the most sensitive portion, the points being recognized when but a twenty-fifth of an inch apart; the inner surface of the tip of the fore-finger, one-twelfth of an inch, comes next, while on the middle of the back, when the points were less than two and a half inches apart, the impressions could not be distinguished. In many forms we find accessory tactile organs, as in the whiskers, or as they are technically called, *vibrissæ*, of the cat and other animals. These hairs are in connection with branches of the fifth pair of nerves. It was a favorite experiment with the older naturalists to remove these whiskers, and it is claimed that when thus deprived, cats were unable to catch rats, rats unable to find their holes, etc. On the other hand, with the eyes bandaged, and the use of the senses of smell and hearing prevented, rabbits were able to find their way about by the whiskers alone. The wings of bats have been shown by the researches of Spallanzoni, and later of Schöbl, to be extraordinarily sensitive, and well supplied with nerves. By their aid alone, and without any assistance from any other sense, bats are able to avoid all obstacles in their flight.

Taste is also well developed in this group, and has its seat in the tongue and palate. Special organs of taste, as developed in man, are the papillæ, of which three principal forms are distinguished, the larger and least numerous type of which (circumvallate papillæ) are richly supplied (and the others to a less extent) with peculiar cellular structures called gustatory buds, and which are supposed to receive the impressions, and through the nerves with which they are connected (branches of the glosso-pharyngeal) to carry the sensation to the brain. Against this idea that the gustatory buds are organs of taste may be mentioned the fact that they occur in places (*e. g.*, the epiglottis) where this sense is wholly lacking. Much of what we usually consider as taste is in reality smell, and the experiment of holding the nose and trying

to taste different substances with the mouth alone is very instructive in this connection.

The olfactory organs of the mammals differ from those of other vertebrates in the perforated cribriform plate of the ethmoid through which branches of nerves go to the nasal cavity, and also in the secondary sinuses found in the frontal and superior maxillary bones by which the extent of surface is increased, though it is not yet certain exactly what part these cavities play in the perception of odors. The special seat of the sense appears to be in that portion of the mucous membrane which covers the middle and superior turbinated bones. In this membrane Max Schultze has found peculiar cellular structures, which may possibly prove to be the ultimate sense organs.

Eyes are present in all mammals, though in some cases (moles, etc.,) these organs are so covered by skin and hair that the extent to which they are of use by the animal is very small. As a rule, all three eyelids are present, but in man and the apes the third (the nictitating membrane of reptiles and birds) is rudimentary, being represented by the so-called semilunar fold at the inner angle of the eye. Of the eye itself we may say that the peculiar modification of the choroid, known as the tapetum lucidum (a fibrous membrane with green or blue metallic reflections), is present in many mammals, and is the cause of the peculiar appearance of the eyes of many animals (*e. g.*, cats) in the dark. The sclerotic never develops a bony ring, nor does the choroid ever give rise to that peculiar fan-like structure, the pecten of reptiles and birds, or the similar falciform process of fishes. Another distinction from the eyes of birds is the fact that the ciliary nerves penetrate to the iris from every side (instead of entering beneath), and then branching, have a circular distribution. Recent studies have greatly extended our knowledge of the structure of the eye, especially in the human being, but we are as yet in the dark as to what part each portion plays in the phenomena of sight. We know from "Purkinje's figures" that the visual sensations originate in some part of the retina, between the retinal vessels and the choroid coat, but how is as yet unascertained. We know that the posterior portion of the retina is made up of a series of "rods and cones," but what part these play is uncertain, and the fact that in many vertebrates (*e. g.*, snakes) the cones alone are found does not help us out of our difficulties. Investigations have shown that in connection with the rods a color is produced which is known as the "visual purple," and which is affected by light to the extent of entire bleaching, and by some this pigment is supposed to be connected with the perception of color; but when we learn that in the "yellow spot," where vision is most distinct, the visual purple is wanting, this view appears untenable. In short, while we have a detailed and accurate knowledge of the anatomy and histology of the organ of vision, we know comparatively little of its physiological action.

The ears of the mammalia differ from those of all other vertebrates in having the quadrate bone (which in the other forms serves to connect the lower jaw with the skull) as a member (the malleus) of the chain of small bones of the ear, connecting the tympanic membrane with the labyrinth. In all, except the monotremes, we also find a new feature in the labyrinth, a spiral portion, the cochlea. What part this cochlea plays in the act of hearing is not yet settled. In it is found a long series of fibres known as the "organ of Corti." From the fact that each of these fibres is in connection with a nerve fibre, and that from base to apex the series diminishes in length, it has been supposed that it is the function of this portion of the ear to recognize pitch, each fibre vibrating to its own peculiar note. The greatest objection to this view is the

fact that in birds, which certainly have the power to recognize pitch, the organ of Corti, together with the whole cochlea, is absent.

The Mammalia, following the most recent classification, that of Dr. Gill, are divided into three sub-classes, Ornithodelphia (comprising the Monotremes alone), the Didelphia (the Marsupials), and the Monodelphia, which embraces all the remaining forms, which are distributed among twelve orders. The Ornithodelphia have the episternum and coracoid-bone developed as much as in birds. Their reproductive organs follow the same plan, emptying as they do together with the intestine and urinary organs, into a cloacal chamber; while the milk-glands have no distinct nipples.

In the Didelphia the anterior commissure of the cerebral hemispheres is well developed, the corpus callosum is rudimentary. The young when born are very small and imperfectly developed, and are usually carried in a pouch, attached to the nipples until well developed. In these, as in the Ornithodelphia, no placenta is found.

The Monodelphia, the highest sub-class, have the anterior cerebral commissure small, the corpus callosum large. The young are retained in the uterus until of nearly perfect development, and nourished by the mother by the intervention of a placenta. As in the Didelphia, the urogenital and intestinal openings are distinct, no cloaca being present, while the episternum is wanting, and the coracoid is but very feebly developed, and never connected with the sternum.

SUB-CLASS I. — ORNITHODELPHIA.

ORDER I. — MONOTREMATA.

THE two very remarkable animals whose natural history we are now about to discuss are, as far as appearance goes, so unlike each other that it is no wonder that their affinities were not at first recognized. Geoffroy St. Hilaire was one of the first naturalists to detect their relationship, and he selected for them the ordinal name of *Monotremata* in reference to the remarkable birdlike anatomical feature which is common to both, viz.: the possession of only a single aperture, "the cloacal aperture," through which the contents of the intestines and the products of the urinary and genital organs pass outwards.

Both of the forms are confined to Australia and the adjacent island of Tasmania; and, whether we regard them merely with curiosity as to their appearance and habits, or with the eyes of the scientific zoologist, they are equally worthy of receiving a more than ordinary share of attention in any zoological work. Especially to the evolutionist are the two forms important, for without the rational explanation which the theory of evolution affords for all the abnormalities they possess, they would indeed deserve to have applied to them the term "paradoxus," which was employed as a specific name by the German naturalist Blumenbach for the Water-mole or Duck-mole of the Australian colonists, to which we shall first turn our attention.

The Duck-mole (*Mallangong* or *Tambreet* of the native Australians) owes its popular names to its aquatic and burrowing habits, and to the duck-like bill which it possesses. The latter peculiarity is referred to twice in its scientific name, *Ornithorhynchus anatinus*, while the name under which it was first described at the end of the last century by Dr. Shaw, *Platypus anatinus*, was suggested on account of the webbed feet which its aquatic mode of life renders necessary. Adult specimens measure about eighteen inches in length from the point of the bill to the tip of the tail, the upper half of the bill being three inches long by two in width, and the tail as much as four and a half inches by rather more than three. The females are smaller than the males, but present no other sexual peculiarities except the absence of a spur, which will be afterwards referred to. The general color of the fur in both sexes is deep brown, paler on the under parts of the body, and brighter in the young. The bill and web of the forefeet are naked, and the tail is covered with coarse hairs, which eventually become worn off from the under surface. Two kinds of hair are noticeable in the fur, one extremely fine and close-set, forming the dense under fur, which is protected from the water and soil by an outer coating of coarse flat hairs. The latter are peculiarly shaped, for only their free ends, which project beyond the under fur, are flat, and are set on at an angle to the slenderer attached ends.

The long upper and lower jaws are covered with an extremely sensitive naked skin of a grayish color, which is for the most part firmly attached to the underlying bones, but possesses a flexible lip-like border all round the mouth, and is raised into a frill-like fold round the base of the bill, which in burrowing and searching for food in the mud is turned back so as to protect the eyes and prevent the soiling of the fur. The nostrils are situated near the front of the upper bill, and very often the Duck-moles are seen

lying in the water with little but these apertures above the surface. The position of the small but brilliant eyes is rendered more evident by a bright tawny spot situated over them, but on account of the absence of a pinna, the ears are easily overlooked, except in the living animal, where their orifices are kept well opened. The fore legs are short, but more powerful than the hind; as in many other aquatic forms, they are directed outwards from the body, and are thus unable to support the body from the ground. Each foot has five toes provided with strong claws, which are blunt on the fore feet, but pointed and more slender and curved on the hind feet. The web between the toes in the fore feet extends further than the claws, and when fully spread out



FIG. 1. — *Ornithorhynchus anatinus*, Duck-mole.

forms an expanse of more than four inches wide; on the hind feet the web only extends to the base of the claws, is covered with short, close hairs, and connects the three middle toes more closely with each other than with the outer and inner toes, which are consequently capable of more independent movement.

The male Duck-moles have a movable spur on the hind legs attached to a prominence on the ankle-bone (Fig. 2), and this is perforated by a canal which passes down through the muscles of the thigh from a gland situated superficially in the loins.

Cases are well authenticated in which wounds caused by the spur have occasioned very serious symptoms, but it is noticed that the natives handle the animals without any hesitation, and it is certain that attempts made to cause both Duck-mole and Ant-

eater to inflict a wound have been unsuccessful. It is probable that the spur is not so much an organ of defence, as of offence during the breeding season, for males have been caught at this time with recent ulcerated wounds, rendering their skins valueless.

On opening the mouth of the Duck-mole the internal surface of the lower lip is seen to be transversely ridged in a manner somewhat similar to the inner surface of a duck's bill, and obviously serves the same purpose of straining off the excess of water from the particles of food collected. Each jaw is furnished with four horny teeth, of which the two situated farthest forward are long, narrow ridges, while the others resemble in their position and shape the grinding teeth of other mammals. The tongue is also partly covered with rough, horny spines, and has a projection towards its hinder part which serves to direct the food collected into two large cheek-pouches.

The skeleton of the Duck-mole is remarkable for the constitution and strength of the girdle of bones which connect the fore-limbs with the trunk, and also for the size of the prominences on the limb-bones which serve for the attachment for the strong digging muscles. The burrows which the strong limbs and claws thus enable the animal to form have been recently carefully studied by Mr. G. F. Bennett, while endeavoring to secure further information as to the condition in which the young are deposited. A little above or below the ordinary water-mark of the streams and ponds in which the

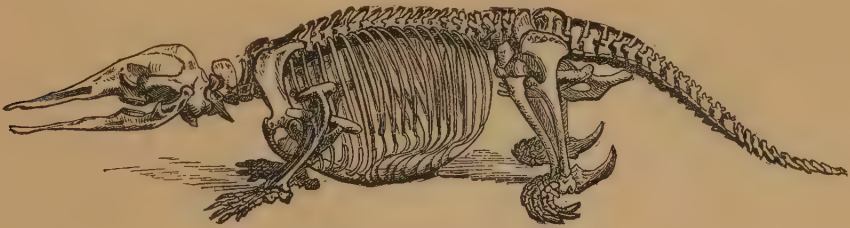


FIG. 2. — Skeleton of Duck-mole.

Duck-mole lives are to be seen holes four inches wide, leading into long serpentine passages of somewhat greater diameter, which usually ascend steeply up the banks and terminate in a chamber often as much as twenty feet above the water-level. In such a chamber (a foot and a half long by a foot wide) the Duck-mole constructs for her young a nest of dried grass and gum-tree (*Eucalyptus*) leaves, and the high situation of the nest secures the safety of the young even in the highest floods. Secondary chambers nearer the water are probably formed as temporary resting-places for the mother while constructing her burrow.

Mr. A. B. Crowther has recently communicated to the Royal Society of Tasmania some interesting observations on the habits of the Duck-mole. He succeeded in keeping a young one for three months; it was fed on worms and pieces of fish, the former being taken so greedily that it is reasonable to suppose that they constitute part of the natural food of the animal. The contents of the cheek-pouches of the freshly-shot animals, however, are mostly fresh-water shrimps, water-fleas, and beetles. The hard chitinous coats of the latter are not rejected, but ground into a fine powder, and swallowed with the rest of the food. "For the most part their food is taken under water; they turn over the sand and small stones at the bottom with their powerful bills, and collect in this manner in their cheek-pouches whatever they discover; then they rise to the surface and triturate their food before swallowing it. This trituration is indicated by a slight lateral movement of the jaws."

The time during which the creatures remain under water, from one to five or six minutes, depends upon the supply of food; if this be plentiful they rise rapidly to the surface. It is obvious that the cheek-pouches must be very serviceable in view of the fact that the food has to be triturated, and that the animal requires to rise frequently to the surface to breathe.

In swimming the forepaws are widely expanded and convex forwards, the animals propelling themselves chiefly by these. When diving the head is rapidly thrown beneath the body, the front paws quickly moving until the bottom is arrived at, the tail turning from side to side as a rudder.



FIG. 3.—*Echidna hystrix*, Porcupine Ant-eater.

On land the web of the front paws is doubled into the palm, the claws being thus left free for burrowing, in which they are the chief agents.

"They soon become very tame in captivity; in a few days the young ones appeared to recognize a call, swimming rapidly to the hand paddling the water; and it is curious to see their attempts to procure a worm enclosed in the hand, which they greedily take when offered to them. I have noticed that they appear to be able to smell whether or not a worm is contained in the closed hand to which they swim, for they desisted from their efforts if an empty fist were offered. Although so tame they refuse any handling, especially on touching the bill and tail; not so, however, with the side, which they appear to like scratched, turning over and coming back several times to have the operation repeated."

"The young ones I could safely permit to run about the room, but the old one scratched so incessantly at the wall that I had to shut it up. Then it lay quietly throughout the day, but on the approach of night it renewed its struggles for freedom. If I startled the animals from their sleep it invariably produced a general growling or murmuring."

The Porcupine Ant-eater, a native of New South Wales and West Australia, owes its common name to its habits and to the stout spines with which the whole of the upper surface of the body is covered. Like the ant-eaters of South America, the snout and tongue are very long, and this resemblance induced Dr. Shaw to describe the Australian animal under the same generic name (*Myrmecophaga*). This was altered by Cuvier, however, to *Echidna* (the Greek word for viper), on the supposition that the spur of the males is capable of inflicting a poisoned wound. He associated with this the specific name *hystrix* (a porcupine), and under this scientific name, or a similar one (*E. aculeata*), the animal is still described. As the term *Echidna* is also employed for a kind of snake, many zoologists prefer for the ant-eater the name *Tachyglossus aculeatus*, which was formed in reference to the rapid motion of the slender tongue while collecting the insects which constitute the food of the animal.

If we compare the ant-eater with the duck-mole, we find that the differences are such as are to be attributed to the totally different mode of life of the two animals. In one habit they agree,—that of burrowing,—and the skeleton of the ant-eater presents the same robustness as we find in the duck-mole. But we miss the webbed feet, the smooth coat, and the odd bill of the duck-mole, and find them replaced by structures more suitable to the terrestrial habits, and to the mode of feeding of the ant-eater. In size

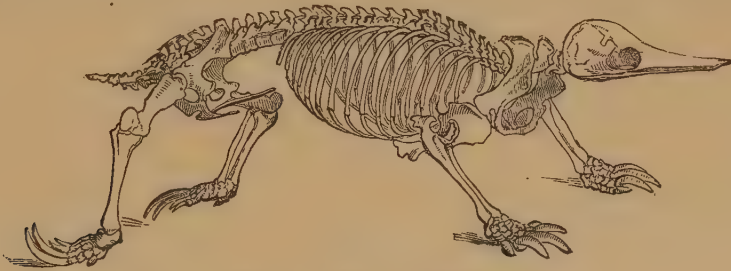


FIG. 4.—Skeleton of *Echidna*.

the ant-eater is considerably smaller—not more than a foot in length—the tail is rudimentary, being concealed by the fur and spines, while the slender, naked snout measures an inch and a half in length, and decreases from a width of three-fourths of an inch at the base to less than half an inch at the tip. The general color is dark-brown: the spines, almost three inches long, which cover the upper surface of the body, are dirty white, tipped with black, and the rest of the surface, except the muzzle, is covered with coarse brown hair. As in the duck-mole, the anterior limbs are more powerful; the toes are armed with thick nails, which are of service in digging up the earth in search of food. The hind-feet rest chiefly on the inner side, in such a way as to raise from contact with the ground and preserve from wear the claws of the outer four toes. These are employed in throwing aside the earth dug out by the fore-feet, and their position in rest, with their concave surfaces turned outwards, shows that they are admirably adapted for this purpose. The claw of the second toe is especially long, while the inner or great toe is itself very short, and is only armed with a flat nail. The aperture of the mouth is very different from that of the duck-mole,—being confined to the tip of the snout, and serving merely to give egress to the tongue. In accordance with the ant-eating habits of the animal, this organ is long and very protractile: the salivary glands, especially that situated below the floor of the mouth (submaxillary), are much enlarged and pour out on to the tongue a viscid secretion which serves to attach to it the insects with which it comes in contact. The ant-eater has neither teeth nor

cheek-pouches, but both the tongue and roof of the mouth have horny spines, between which the insects are crushed before being swallowed.

Having now described the appearance and habits of the two typical and best-known species, a short reference to the others, with some account of their systematic relationships, may suffice. The order Monotremata is divided by zoologists into two families: the ORNITHORHYNCHIDÆ with the sole species described above, and the TACHYGLOSSIDÆ with four known species. One of these seem to differ little from the *E. hystrix*, except in its greater length and in the greater development of its fur, which almost conceal the spines. It is known as *Echidna setosa*, and is a native of Tasmania. It is possible that it is only a local variety of the other, depending on climatal conditions; but within the last two or three years our knowledge of the family has been increased by the discovery of two additional species, both from the comparatively little-known island of Papua or New Guinea. Except a peculiar form of wild pig, no mammals were known to occur on this island other than pouched forms similar to those inhabiting the neighboring Australian continent. It is not too much to anticipate that science will be still further enriched by the explorations of this interesting region now in progress. One of the species referred to was brought from Port Moresby, in West Guinea, and named *Echidna lawesi*, while the second (*Echidna* [*Tachyglossus*] *bruijni*) was first established by Prof. Peters on a skull acquired for the museum at Genoa, by the Marquis of Doria. M. Paul Gervais has, however, recently had the opportunity of studying two entire specimens of the latter, procured for him with the assistance of M. Bruijn, of Ternate, and finds such important points of difference from the Australian forms that he proposes a new genus (*Acanthoglossus*) for the reception of this species. It appears that the natives hunt these *Nodiaks* high up in the Arfak mountains, dislodging them by the aid of dogs from the deep burrows in which they live. Besides being more robust than the Australian ant-eater, the *Nodiak* has blackish fur with white spines, and only three toes to each foot, while its snout and tongue are three times as long, and the latter organ, instead of being smooth towards the tip, is provided with three rows of horny spines, to which the animal is indebted for its new generic name.

Foremost among the anatomical peculiarities which the Monotremes possess in common with other Mammalia, must be mentioned the mammary glands which supply the milk for the nourishment of the helpless young. The reason that these structures did not at first attract the attention of naturalists is to be sought for in the fact that they are of large size only during the breeding season, and rapidly disappear after their function has been discharged, as well as in the fact of the total absence of any nipple or teat. In the duck-mole the glands, which are situated on the belly just in front of the hind-legs, open by very numerous, close-set apertures on the surface of the skin among the hairs. The apertures, which are little larger than those through which the hairs emerge, occupy an oval spot five lines by three lines in diameter, and Owen's researches have determined that the young duck-mole's mouth is specially adapted to avail itself of the milk that escapes upon this surface, the bill being short, flexible, and sensitive, while the broad tongue is advanced to the front of the mouth.

The young of the echidna also possess this peculiarity, the face being proportionately very much shorter than in the adult. Simultaneously with the increase in size of the milk-glands in the echidna, however, the surfaces on which they open become turned in so as to form two little pouches, which are only sufficiently large to contain the newly-born young, but which nevertheless foreshadow the larger skin-pouches in

which the young of the kangaroos and similar marsupial animals are nursed for a long time.

The presence of mammary glands, however, is only one of numerous structural points which associate the monotremes with the rest of the Mammalia. Even in features which seem most to recall the birds and reptiles, we find on closer examination that the intimate structure is decidedly more like that of the higher animals. A striking instance of this is the cochlea of the internal ear, which is spirally coiled in mammals, but simply curved in reptiles, birds, and monotremes; yet in spite of this agreement in form, the internal arrangement of the cochlea is distinctly mammalian in the duck-mole, and not like that in reptiles and birds. So with the chain of small bones in the cavity of the drum of the ear: as in all mammals, these are three in number, whereas in reptiles and birds only one is present, and the bones corresponding to the other two enter into the formation of the joints of the jaws. A curious approximation to the reptiles and birds, however, is afforded by the monotremes in the form of that ear-bone which is common to the three great groups; for, instead of being stirrup-shaped, as in other mammals, it is column-shaped, as in the reptiles and birds.

One of the most remarkable of these anatomical peculiarities which the monotremes share with certain lower vertebrata is the structure of the girdle of bones connecting the fore-limbs with the trunk.

In man the shoulder-blade (scapula) is not connected with the trunk, except indirectly by means of the collar-bone (clavicle), which runs between the acromial projection from the scapula to the upper end of the breast-bone (sternum). Now, in the monotremes the clavicles are supported along their whole length by the transverse arms of a T-shaped interclavicle, the perpendicular part of the T being a broad plate which joins the breastbone behind. The greater solidity thus produced is increased by the fact that the small curved projection which we know as the coracoid process in the shoulder-blade of man, is in the monotremes an independent bone of considerable strength, which not only forms part of the shoulder-joint, but also is directly connected with the sternum. Both interclavicle and distinct coracoids are peculiarities inherited from reptilian ancestors, which are almost lost in the higher members of the mammalian series.

Again, the structure of the reproductive organs already referred to is another reminder of the reptilian affinities of the monotremes and of the low position which they would be allotted in a genealogical tree of the mammals.

In spite of such pronounced affinities with the lower classes of vertebrates, a great gap exists between any existing reptiles and these lowest mammals. So fragmentary is the record which fossils yield us of the forms which have lived in past geological ages, that we are unable to point to any group of fossil or living reptiles as near relatives of the monotremes. The only remains that have been found are of comparatively recent origin, and point to the former existence of gigantic ant-eaters on the Australian continent. It is to be hoped that continued researches may yet reveal further links in the chain of forms which connected the earliest mammals that appeared on the earth's surface with the reptiles of geological ages further back. It is improbable enough that these earliest milk-givers shared the peculiar external appearance and habits of either the duck-mole or ant-eater of the present day; but it is certain that they must have resembled these animals in the more important peculiarities of the skeleton, to which attention has been drawn, as well as in the rudimentary condition of the milk-glands, and the mode in which the young are brought forth. This last

point is of so great interest, from a zoological point of view, that it appears desirable to describe, at some length, the present state of our knowledge on the subject. As already indicated, the structure of the reproductive organs of the Monotremata is sufficiently different from that found in other mammalia to warrant the formation of a special subclass for their reception. Naturalists have consequently exerted themselves to discover the physiological conditions determined by these structural peculiarities, to find out, in fact, the condition in which the young are born, and the arrangements for nursing them. For most of our information on this subject we are indebted to the veteran English anatomist, Owen, who by his personal investigations, and with the aid of Australian correspondents, has done much to clear up this very obscure subject.

The breeding-time of the monotremes is in the months of August, September, and October. The testes of the males (which, unlike the same organs in the higher mammalia, retain the position in front of the kidneys where they are developed), are at this time much increased in size, — from the size of a pea to that of a pigeon's egg, — while eggs in various stages of development have been found in the females in these months. In the higher mammalia the egg as it leaves the ovary is on an average only $\frac{1}{125}$ of an inch in diameter, irrespective of the size of the animal. Increase in size only takes place concomitantly with the process of cleavage and development of the egg. In the monotremes, however, the ovarian eggs are more than ten times as large to begin with, and attain in the oviduct a diameter of a quarter of an inch before the first steps of development take place. As in reptiles and birds there is no connection whatever between the eggs and the oviduct, which can afford nutrition to the embryo, and the larger size of the eggs is simply attributable to the presence of a larger amount of food-yolk which renders the embryo independent of such nutrition. How long the process of development within the mother lasts is uncertain, but it is ascertained that the eggs, of which the envelope is flexible and white, attain the size of a crow's before the envelope is broken. Whether this rupture is effected within or without the mother [*i. e.* whether the mother is viviparous or ovo-viviparous] is so far unknown, but it is of interest to note that a provisional knob exists on the nose of the youngest progeny discovered comparable to that by the agency of which a chick breaks its shell. Such very young specimens have been secured, both of the duck-mole and of the ant-eater, measuring about two inches in length. They resemble each other in the absence of any hairs, and in their reddish color, due to the vessels shining through the very thin skin; but the habits of the parents are so entirely different that we have to expect some difference in the provisions made for the care of such helpless little creatures.

The nest which the duck-mole constructs for her young has been already described. In such they are found to the number of two or three, and it is probable that they remain there for six or eight weeks, entirely nourished by the milk of the parent until they have acquired a hairy covering and have attained the length of six or eight inches.

The porcupine ant-eater on the other hand carries its young about with it in a pair of pouches on the under surface of the abdomen, which are no more than two inches in diameter, and whose openings (concealed by the hair of the region) look towards each other. At the bottom of these pouches, which are not present except in females with young, are the numerous (fifty) orifices of the milk-ducts, opening simply on the smooth surface of the skin.

It is obvious that although such a pouch may serve to contain the recently-born echidna, its dimensions will soon be inadequate for it, and accordingly we hear of

specimens being caught with the young clinging by means of its claws to the hair of the mother, only the head being concealed in the pouch.

Such a provision for carrying about the young would be out of place in the aquatic duck-mole, which may remain entirely under water for seven or eight minutes, and at any rate only pushes its nostrils up to the surface for breathing. However small the size and temporary the character of the ant-eater's pouch, it is, nevertheless, a structure of peculiar interest in view of the fact that the other quadrupeds of the Australian region are all of them possessed of a similar though more developed receptacle for the young. We are led by its study to the conclusion that the pouched mammals, the description of which we are next to take up, must in the course of their development from lower forms have passed through a stage in which the pouch was of very much the same character as in the porcupine ant-eater.

R. RAMSAY WRIGHT.

SUB-CLASS II. — DIDELPHIA.

ORDER I. — MARSUPIALIA.

As has been already observed in describing the manner in which the Porcupine Ant-eater carries about her young, the quadrupeds of the Australian region are, for the most part, possessed of a well-developed fold of skin round the region on which the milk-glands open, which constitutes the pouch or *marsupium* from which the ordinal name "Marsupialia" is derived.

If this were the only peculiarity of the group, it would hardly deserve to be set aside from the others except as an order; but the pouch is associated with, and indeed is necessitated by, certain peculiarities of the reproductive system which are of deep anatomical significance, and consequently naturalists agree in assigning to the order also the rank of a sub-class (Didelphia), equal in value on the one hand to the Ornithodelphia (Monotremes), and on the other to the Monodelphia (the higher orders of mammals). The group, however, as we shall afterwards show in detail, is by no means to be regarded as exactly intermediate between the two other sub-classes, but the existing members of it are rather to be considered as extremely modified descendants of such an intermediate group.

One of the most interesting points in connection with this order is the contrast between its extremely limited geographical distribution at the present time and in past geological ages, as shown by fossil marsupial remains all over the world. Another of great interest to the evolutionist is the study of the relation of the various families to each other, and to fossil forms — a study which discloses perhaps better than anywhere else in the animal kingdom the influence of different habits of life in bringing about extreme modifications of external form without affecting essential anatomical characters. Again, in such a study we are led to contemplate the superficial resemblances induced by similar habits, by comparing the herbivorous, carnivorous, and insectivorous quadrupeds of the rest of the world with those representative forms which discharge the same functions in nature's economy in Australia.

A glance at the map of the world will show the very curious distribution of existing marsupials. All the families but one have their home in the Australian region; that is, either on the continent of Australia, the Island of Tasmania to the south, that of Papua or New Guinea to the north, that of Celebes to the northwest, or, finally, on the small islands which lie to the east and west of Papua. The remaining family (the opossums) is confined to South America and the southern parts of North America. This characteristic difference between the Australian and American marsupials extends also to the fossil forms found in these regions, for the earliest marsupial remains which have been detected in both countries are distinctly allied to the existing Fauna.

As we shall see further on when discussing the remains of extinct marsupials, it will be necessary to go very far back in the series of fossiliferous rocks before we can hope to find remains of the common ancestors of the American and Australian forms. Researches in the earliest secondary rocks may yet fill the gap.

Before discussing the natural history of the various families, a short sketch of the anatomical features common to all may be of service.

In none of the orders of the higher mammalia do we find such wide limits as to the size of the body, for the order includes kangaroos as tall as a man, and little mouse-like creatures of dwarf proportions. The fur is in most cases long and soft, its coloring rarely very marked, and often very sober. In the structure of the skeleton the marsupials are rather allied to the higher mammals than to the monotremes, for the peculiarities mentioned above as to the ear-bones and shoulder-girdle of the monotremes are here replaced by arrangements entirely similar to those in other quadrupeds. The pelvic girdle, however, shares a marked peculiarity with the monotremes—the possession of well-developed epipubic bones jutting out in a forward direction from the pubes. The function of these structures will be discussed later on. The lower jaw is always characterized by the inflection of the angle, a peculiarity which has assisted in the recognition of the marsupial character of the earliest fossil mammalian remains, which almost invariably consist of lower jaws. The number of bones in the vertebral column is remarkably constant, except in the caudal region: we shall find that some forms have a well-developed tail, which may act as a sort of fifth leg, as in the kangaroos, or be used in climbing (Phalangiers), while in others that organ is more or less rudimentary (Wombat, Koala).

The relative length of the fore and hind limbs is very different in the different groups—the difference is especially striking in the kangaroos, where the fore limbs are particularly short. The bones of the fore arm are distinct, and allow of a rotary motion, the one around the other; the same is true of the bones of the hind legs in the climbing forms, but in the leaping forms such rotation is not possible. Of the toes of the hind feet, the inner one is sometimes opposable after the fashion of a thumb. This inner toe may be absent, or the second and third next it may also disappear or be much reduced.

The brain of the marsupials is small, and consequently the cavity of the skull is relatively small as compared with the bones of the face. The surface of the brain is almost destitute of convolutions, and the two halves of the brain are less intimately joined by the corpus callosum, than is the case in the higher animals.

By far the greater number of mammals have two sets of teeth, a milk-set and a permanent set, the latter, as age advances, successively displacing the former from below. In certain orders, however (Rodentia and Insectivora), some of the members have a more or less complete milk-set, while in others the milk-teeth are wholly suppressed: there is no question but that the latter are the more modified forms. Now, in the marsupials we find that there are only four teeth (one molar on each side in each jaw), which have milk-predecessors, and from the above consideration we argue that these are merely vestiges of a full milk-set possessed by the ancestors of our existing marsupials, and regard the condition as one of the proofs that existing marsupials are very much modified representatives of that half-way stage of mammalian evolution for which Huxley has proposed the name *Metatheria*.

As to the number and arrangement of the teeth, differences are to be met with in this order of far more striking extent than in any of the higher orders. In by far the greater number of cases (except the wombat) the incisor teeth are unequal in number in the upper and lower jaw, and a great difference is observed to be associated with the character of the food. The vegetable-feeders, for instance, have teeth with constantly growing roots, like rabbits, and the formula for these is $\frac{1}{1}$, $\frac{2}{2}$, or $\frac{3}{3}$ on each side. In the insectivorous and carnivorous forms, on the other hand, where the roots do not thus increase, the formula is $\frac{4}{3}$, $\frac{5}{3}$, or $\frac{5}{4}$ on each side. Again, in the carnivorous forms the

canine teeth are well developed, whereas, in the vegetable-feeders they may be much reduced or absent. The premolars are double-fanged, and are usually $\frac{3}{2}$ on each side; the commonest formula for the true grinders is $\frac{4}{3}$, but it may rise (in the banded ant-eater) to $\frac{6}{6}$, or fall in the flying phalanger to $\frac{3}{3}$. The mode of succession of the teeth in the kangaroos is singular, for the hinder teeth eventually replace, in function, those in front, which have become worn away—a peculiarity also met with in some of the higher hoofed animals.

The stomach also varies in shape with the food, being simply oval or rounded in the carnivorous or insectivorous forms, while in the herbivorous kangaroos it is converted into a gut-like tube, sacculated like the colon, sometimes as long as the body, and occasionally provided, near the entrance of the gullet, with two blind sack-like appendages.

The vent of the intestine opens independently behind the genito-urinary passage; thus there is no cloaca, such as occurs in the monotremes; at any rate, if present at all, it is very much reduced. In this respect the marsupials agree with the higher mammals, for only in the females of a few forms is there any indication of a cloaca.

The reproductive organs in both sexes present many peculiarities in their structure which do not find a parallel in any of the higher orders of mammals. In the female they consist of two ovaries, two oviducts, two uteri, two vaginae, which open separately into the genito-urinary passage, and, in addition, in some forms there is also present a cul-de-sac, originally double, which originates from the vaginae where they communicate with the uteri, and which is usually blind, but may communicate with the urogenital sinus (as in Bennett's kangaroo), forming there the so-called median vagina. The ovaries differ in size according to the number of young brought forth at a birth, being thus small in the kangaroos and large in the opossums. A similar difference is observed in the oviducts and uteri, which are short in the kangaroos and long in the opossums. The lateral vaginas are always more or less curved, and sometimes tortuous in their course. On the whole, the researches of Brass have shown that the opossum family is that which is nearest to the Ornithodelphia in the structure of the reproductive organs.

The male reproductive organs exhibit some peculiarities not to be met with elsewhere in the mammalian series. The testes are no longer abdominal in position, but descend through an inguinal canal (which remains permanently open) into the scrotum, or pouch, which is situated in front instead of behind the penis. This organ may be simple or bifurcated at its extremity; the former is the case in the larger kangaroos and other forms, where only one of the uteri is found to be pregnant at a time, the latter in the opossums, etc., where eggs from both ovaries are impregnated at the same time.

The eggs of the marsupials agree in size with those of the higher animals, the amount of yolk, however, is somewhat greater, and therefore in their structure they hold a position midway between those of the monotremes and the higher mammals.

The time required for development of the embryo within the mother varies from twenty to forty days; in all cases the young are born in a much less developed and more helpless condition than is the case in any of the higher animals, although, as is well known, very different degrees of development may be observed even in nearly-related forms of them.

The nutrition of the foetus, while it is in the mother's womb, is effected in a different way from that which is found in the higher animals. There the vessels of one of

the fœtal membranes, the allantois, come into very close relationship with the vessels in the lining membrane of the uterus; here, on the other hand, there is no such allantoic placenta. That the fœtus is nourished while in the uterus is obvious, and it is probable that this is effected through vessels in the yolk-sac, which is of large size.

It was suspected by some naturalists that the median vagina might serve to contain the embryo after its discharge from the uterus, but Pagenstecher's observations, taken together with those of Owen, point to the fact that no such delay occurs, and that the embryos, when born, are at once conveyed by aid of the mother's lips to the nipple, to which they are attached for a longer or shorter time.

The milk-glands of the marsupials are much in advance of the state of development observed in the monotremes, being much more compact, and being further provided with teats. Their number bears a certain relation to the number of young which may be produced at a birth, being four in the kangaroos, wombat, koala, banded ant-eater, and thirteen in the Virginian opossum. They are, however, more numerous than the usual litter, for the young of two successive births may be suckled for a short time together. The teats are long and slender; when the mother is not suckling, they are withdrawn within a sheath. As already observed, the skin round the teats is raised into a fold, which gives rise to the characteristic pouch. The inner surface of the skin of the pouch is almost hairless, but is lubricated by the secretion of the sebaceous glands. The mouth of the pouch is generally directed forwards. In one or two forms, however, it opens backwards (*Perameles*, *Chaeropus*). The aperture of the pouch can be closed at will by a strong skin muscle, the fibres of which are arranged round the margin of the aperture. In certain forms the pouch is rudimentary or absent, and it is probable that in these forms the young are further developed within the body of the mother than is the case with those in which it is a marked feature.

Prof. Huxley remarks that the pouch is evidently a modification related to the abnormally early birth of the fœtus, and he argues that this may have been brought about by the arboreal habits of the early marsupials, in which it may have been "advantageous to get rid of the young from the interior of the body at as early a period of development as possible, and to supply them with nourishment during the later periods, through the lacteal glands, rather than through an imperfect form of placenta."

The most preposterous theories as to the mode of development of the kangaroos were at one time credited by the Australian colonists and even by naturalists. It was thought that the little young were formed at the end of the teat, and indeed the intimate connection which exists between the teat and the young readily explains such a popular conception. Now, however, ripe embryos have been discovered in the uteri, and such have also been observed a few hours after their fixation to the teats. There appears to be no doubt that the transference of the young from the womb to the pouch is effected by the mother's lips, the fore-paws being only employed to hold the lips of the pouch widely open. Both transference and fixation are, however, difficult to observe, for the little embryo, hardly an inch long, is first concealed by the lips of the mother, and then more effectually so by the insertion of the mother's head into the pouch. Even in the largest member of the family, the giant kangaroo, the young, when born, are no larger than a newly-born mouse. It is interesting to compare the degree of development of the hind and fore legs at this stage. While in the fore feet the five fingers are distinctly formed, even to the tips of the claws, the hind feet are more like short fins, slightly notched into three lobes, the inner of which is again perceptibly divided in correspondence with the structure of the adult foot. One of the most

remarkable features about the young kangaroo is the largely-developed mouth and tongue; by their aid the little creature is able to grasp the teat firmly, and in fact the orifice of the mouth may grow smaller after the teat has once been firmly secured in it. The milk is injected into the gullet of the young, passing on each side of the upper end of the windpipe, which is carried as far up as the hinder part of the nasal cavity. In this way the little creatures may breathe, and be fed at the same time, without danger of choking. The injection of the milk is effected by a specially modified part, the cremaster, of one of the superficial abdominal muscles. The epipubic, or so-called marsupial bones (they have nothing to do with the pouch), serve as a sort of pulley by which the cremaster muscles are enabled more effectively to compress the milk-glands.

The duration of the pouch-life of the young varies with the species. The kangaroo, according to Owen, suckles her young for eight months. "During this period the hind legs and tail assume a great part of their adult proportions; the muzzle elongates, the external ears and eyelids are completed, and the hair begins to develop about the sixth month; at the eighth, the young kangaroo may be seen frequently to protrude its head from the mouth of the pouch, and to crop the grass at the same time that the mother is browsing. Having thus acquired additional strength, it quits the pouch, and hops at first with a feeble and vacillating gait, but continues to return to the pouch for occasional shelter and supplies of food, till it has attained the weight of ten pounds; after this it will occasionally insert its head for the purpose of sucking, notwithstanding another fœtus may have been deposited in the pouch, for the latter attaches itself to a different nipple from the one which had been used by its predecessor."

In the summary of facts as to the parturition of the marsupials, special reference has been made to the kangaroos, for more attention has been devoted to the phenomenon in this family than in any other. When discussing the natural history of the various genera, we shall have occasion to refer to any differences which have been observed to be characteristic of these.

Attention has already been attracted to the fact that of all the marsupials, the opossum approaches the typical mammal most closely in the structure of its reproductive organs. Again, the family to which it belongs is one which is represented amongst the earliest mammalian fossils, whilst the families of the Australian marsupials (as fossils show) are of comparatively recent origin. These circumstances, along with the remarkable geographical isolation of the family from the other members of the order, induce us to describe its members first. A further reason for doing so is afforded by the familiarity of one of the species, the common Virginian opossum, *Didelphys virginiana*.

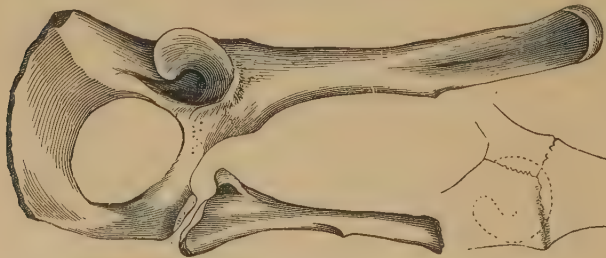


FIG. 5. — Pelvis of opossum, with epipubic bone.

The family DIDELPHIDÆ includes all the American marsupials; most of them are about the size of a rat, and they rarely attain the size of a cat. They feed chiefly on insects, but small reptiles, birds, and eggs are not despised. Two genera are recognized, one, the water opossum (*Chironectes*), differs entirely in its habits from the

other, and has webbed feet (whence its generic name), in adaptation to its mode of life.

All the other species belong to the genus *Didelphys*, and are arboreal, and more or less nocturnal in their habits. Some of these are provided with a pouch, others are destitute of it. In all the teeth are arranged according to the following formula:—Incisors $\frac{2}{2}$, canines $\frac{1}{1}$, premolars $\frac{3}{3}$, molars $\frac{4}{4}$. Of the grinders, the premolars are two-fanged, the molars three-fanged; in accordance with their food their surface is provided with sharp cusps. The feet are five-toed, naked on the under surface, the inner toe of the hind foot is opposable, like a thumb, and is destitute of the short claw which all the other toes possess. The tail is long and naked, except towards the base, where it is covered with fur like the rest of the body.

In the opossums, as in some others of the marsupials (*e. g.* *Dasyurus ursinus*), the occipital through life persists as four bones, the sutures between them never being obliterated. The gape of the mouth is very large, extending back as far as the outer angle of the eye. Bristles are few in number, but those on the nostrils and lips are very long. In some species of the genus the mammæ are contained in a well-formed pouch, but in others the pouch is represented by two cutaneous folds of the abdomen, the mammæ lying between them.



FIG. 6. — *Didelphys virginiana*. Common opossum.

The Virginian opossum (*Didelphys virginiana*), Fig. 6, belongs to the group with a well-developed pouch, and is indeed one of the largest forms, approaching in size the common cat. Its woolly fur is for the most part dirty yellowish, but, especially in younger animals, the tips of the hairs on the back are brownish or blackish; intermingled with these are larger whitish hairs. The tail is scaly, like a rat's, except at the root. The head is much larger in proportion to the rest of the body, but this is largely due to the elongated snout, for the brain-case, and consequently its contents, are of small size, and of a very low grade of development. The sense of smell appears, however, to be well developed, and also that of sight. The ears are naked, black in color, and resemble in texture a bat's wing.

The opossum brings forth a litter corresponding more or less nearly to the number of her teats. These are thirteen, disposed in a circle, six on each side and one in the middle. Except during the pairing season, the opossum leads a solitary life; then, however, it constructs a nest of dried grass for itself in the hollow or at the root of a tree, and this is shared by the young when they are sufficiently old to leave the pouch.

The developmental changes which take place within the body of the mother

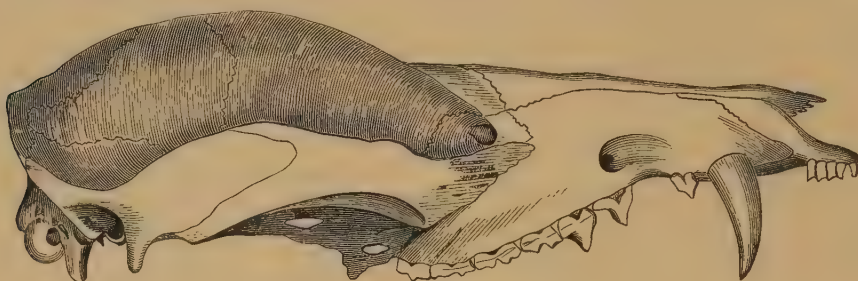


FIG. 7. — Skull of opossum.

occupy from twenty-four to twenty-eight days. The young are then born in a perfectly helpless condition, and only about half an inch in length: they are immediately placed in the pouch by the mother; one being attached to each of the long teats. The mouth at this stage is well formed, and the fore limbs much further advanced than the hind, for the young are enabled to cling to the teat partly by means of the fore claws, while the similar structures of the hind limbs are only afterwards developed. After attachment, the corners of the mouth grow up round the teat, insuring a more perfect channel for the flow of the milk; this is further aided by a well-marked groove on the upper surface of the tongue. The milk is prevented from getting into the

lungs by the same arrangement of the wind-pipe described above in connection with the kangaroo.

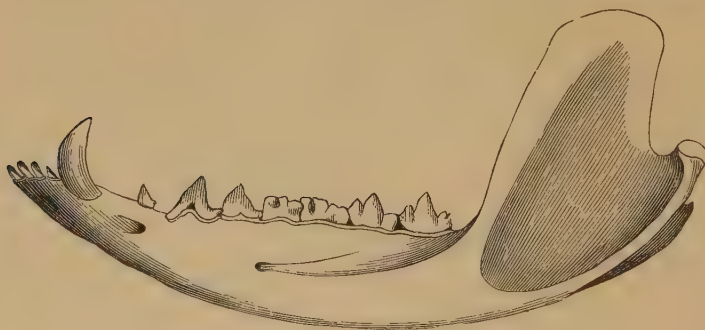


FIG. 8. — Lower jaw of opossum, showing inflected angle.

An interesting fact in view of the occurrence of a well-marked pouch in the male *Thylacinus*, to be afterwards referred to, is that the young male and female opossum,

when first born, can hardly be distinguished, as far as the nipples and pouch are concerned. In both sexes a cluster of little conical elevations (the future teats) are to be observed, surrounded by a low circular ridge of skin, which afterwards grows in over the teats to constitute the pouch. The pouch and nipples of the male soon cease to be developed, and are hardly to be traced in the adult. During the first fortnight after birth the opossum keeps its pouch obstinately closed. In another three or four weeks, the little opossums have attained the size of mice, but do not leave the pouch entirely until after two months or so of suckling. Even when they are able to run about they are still cared for by the mother.

In captivity the opossum is not attractive; it sleeps the greater part of the day, and is with difficulty roused to any active movements.

Until recently two Californian species have been accepted as different from the common opossum, and were first described by Bennett from specimens in the Zoological Gardens in London, under the names *D. californica*, and *D. breviceps*. We learn from Dr. Elliott Coues, however, that these so-called species are not entitled to that rank, but have been merely formed from specimens varying from the average in color and other particulars. He contends that the opossum is very variable, that such variations depend largely upon age and sex, and that there are no characters cited for these species which cannot be found in specimens of *D. virginiana* from the same locality. Age is a great factor in color-variation; half-grown animals, at a little distance, look blackish; old ones, whitish. The paws may differ much in color; generally they are among the darkest parts, but may occasionally be as pale as the rest of the body. Such variation is not only skin-deep, but may affect materially the form and measurements of the skull.

It is probable that the variability which has been established for the Virginian opossum is also characteristic of other species, and consequently that the long list of Brazilian species which have been described may be susceptible of considerable reduction.

The other pouched species of opossum have their home chiefly in Brazil, whence some of them have extended into neighboring provinces. Smaller in size than the Virginian species, they appear to resemble it closely in their habits. Such are the *D. quica*, *D. opossum* (of the size of a squirrel), *D. philander*, and *D. cancrivora*. The last-mentioned prefers swampy situations, and, as its name indicates, lives largely on crabs. These, however, do not form its sole food, for like the other species small birds and reptiles are likewise preyed on.

The remaining species of the genus are characterized by the absence or rudimentary character of the pouch. The young are born, however, in practically the same condition. After they are old enough to leave the teats they are carried on the back of the mother, being securely fastened there by means of their prehensile tails, which are twined round the tail of the mother. This peculiarity has given the name of *D. dorsigera* to the species from Surinam, in which it was first observed; but it is also shared by other members of the section. In size and coloring this opossum resembles the brown rat. Some of the nearly-related forms, *D. murina*, *elegans*, etc., are smaller (the latter being about the size of a mouse); but most of them agree in being deadly enemies to the smaller birds. On the other hand, some of the Peruvian forms (*D. impavida* and *noctivaga*) seem to live almost entirely on the fruit of the banana and other trees.

The water-opossum (*Chironectes variegatus*) referred to above is a native of Guiana and Brazil, is provided with a perfect pouch; its hind feet are large and webbed, in adaptation to its aquatic habits. The *Yapock*, as it is named by the natives, is so otter-like in its habits, although of considerably smaller size, that it was long classed with the carnivorous animals. Its chief food is formed of small fish, crustaceans, and other aquatic animals. After securing these the yapock stows them temporarily in large cheek-pouches. Only five or six young are born in a single litter; like similar aquatic forms, the yapocks live in holes, to which they retire in danger. Specimens are difficult to secure, as they are excellent divers, and it is only occasionally that they are taken by accident in eel-pots.

The remaining families of marsupials are all Australian; some of them, like the opossums, are arboreal forms, others are completely terrestrial in their habits. Krefft believes that all of the forms were derived from ancestors possessing a combination of the carnivorous and herbivorous dentition which we now find only in separate groups, and thinks that in the course of evolution one line of development resulted in those living forms which have two conjoined inner toes (the wombats, phalangers, bandicoots, kangaroos, and kangaroo-rats), while the other culminated in those of truly carnivorous habit which have the toes free (the Tasmanian devil, banded ant-eater, Tasmanian wolf, pouched mice, etc.). There is every reason to regard the native bear, or Koala, as that



FIG. 9. — *Phascolomys wombat* and *P. latifrons*. Common and broad-fronted Wombats.

which among living forms approaches this early type most closely. The most natural way of arranging the families would be that which would express, as far as possible, the probable lines of development, but it will be more convenient to describe in the first place the wombats, for they, although undoubtedly related to the phalangers, possess, nevertheless, certain peculiarities (the result of their different mode of life) which isolate them from the other forms in a natural system.

The wombats constitute the second family of the marsupials (PHASCOLOMYIDÆ) with only a single genus, *Phascolomys*, and but three living species. The commonest of these, the wombat of the natives, and badger of the Australian colonists (*P. wombat*),

Fig. 9, has a pretty wide geographical distribution, being found in New South Wales, South Australia, and Tasmania. It resembles the other species entirely in its habits, so that one description will apply to all. The body is little more than two feet in length, the tail rudimentary, the neck short and thick, and the head disproportionately large. The legs are short, stout, and well adapted for the burrowing habits of the animal, for the toes are armed with stout, curved claws, except in the case of the innermost toe of the hind feet, which, unlike the arboreal forms, is unarmed. The hind feet are further adapted for burrowing, by being strongly concave on the under surface. The animals live chiefly on roots, which they gnaw after the fashion of rodents; and the inspection of the skull and teeth discloses a very strong superficial resemblance to those of a beaver, attributable entirely to the effect which the strong gnawing muscles have on the shape of the skull, and the necessity for the constant growth of the teeth from the roots to replace what is worn away. The incisor teeth, shaped like curved chisels, are two in the upper jaw and two in the lower. They are separated by a wide gap from the molar teeth, a circumstance which increases the resemblance of the skull to a beaver's. The grinders are $\frac{5}{5}$, also, rootless, the foremost of the series being a premolar, and of only half the size of the true molars.



FIG. 10. — Skeleton of Wombat.

The gait of the wombat is a clumsy shuffling, like that of a bear, but it is nevertheless able to get over considerable tracts of ground quickly, proceeding, despite of every obstacle, with untiring patience. Brehm narrates how in the course of its nightly wanderings it frequently rolls over into the bed of a stream, but pursues the direction once taken with the utmost obstinacy till *terra firma* is once more reached.

Wombats are easily caught alive and kept in captivity. They appear to be quite indifferent to their keepers, however, and seem to care for nothing but their food. They are with difficulty roused out of their ordinary good nature or indifference, but are said to be able to take care of themselves with their chisel-like teeth if once excited. In addition to the ordinary wombat two other species are recognized. One of these, *P. platyrhinus*, differs only in considerably greater size and in the yellowish-brown color of the fur, but the second, the hairy-nosed, or broad-fronted wombat, *P. latifrons*, is readily distinguished from either by the silky character of the fur, by the hairy muffle, by the greater curvature of the incisors (they form almost a semi-circle), and by the fact that the enamelled surface of these is directed forwards instead of outwards. It is occasionally regarded as forming a separate sub-genus, *Lasiiorhinus*. Comparatively gigantic wombat remains have been found in recent bone-caves in Australia.

The third family, PHASCOLARCTIDÆ, embraces only the singular koala (*Phascolarctus cinereus*), the native bear or native sloth of the colonists of New South Wales. It has occasionally been confounded with the wombat described above, probably on account of the fact that the natives also occasionally use the same name for it.

The common names, native sloth and native bear, applied to the koala, are both of them justified by peculiarities in appearance and gait of the creature. A truly arboreal

form, its feet are adapted for clasping the branches of trees; this is rendered possible by the long curved claws, and notably by the circumstance that in the fore foot the two inner toes are opposed to the three outer, while in the hind foot the nailless innermost toe serves as a "thumb." These peculiarities result in a very awkward gait upon the ground, to which, however, the koala rarely descends.

The thick-set, short body, the short snout, and large head are somewhat bear-like, peculiarities which find expression in both the common and scientific names.

The general color of the fur, which is very thick and woolly, is grayish, but paler, and sometimes yellowish-white on the under parts. The ears, which are blackish in



FIG. 11. — *Phascogale cinerea*, native Bear, koala.

color, are particularly hairy. The very rudimentary condition of the tail helps to increase the singular appearance of the creature.

Anatomically, the koala is most nearly related to the next family, that of the phalangiers, but to a certain extent it occupies an isolated position, and may rather be regarded as the sole survivor of a family which was more abundantly represented in past times.

The short, thick head produces a certain superficial resemblance between the koala's skull and that of the true wombat, but the teeth are very different; the formula for the koala being $i \frac{3}{1}, c \frac{1}{1}, p \frac{1}{1}, m \frac{4}{4}$.

The koalas live on the leaves and shoots of the young trees on which they climb.

The female is much attached to its young; only one is born at a time, and the little one is carried about on the mother's shoulders long after it is able to leave the pouch.

The Australian bear was first known to Europeans in 1803, and received its scientific name, which signifies ashy pouched bear, from De Blainville. The Australians call it goribun, and have always considered it a valuable animal of the chase. They follow it to the tops of the highest trees, sometimes sixty or seventy feet from the

ground, climbing with an agility that would do credit to any ape or monkey, drive it out on some slender limb, and then either despatch it with a club, or shake it off, the fall either killing or disabling it.

The fourth family, the Phalangers (PHALANGISTIDÆ), embraces certain arboreal forms for the most part small in size, some of which are aided in leaping from tree to tree by the presence of a lateral fold of skin of greater or less extent. They are thus divided into ordinary and flying phalangers. Two genera are usually recognized, *Phalangista* and *Petaurus*, but each of these is again subdivided into a number of sub-genera. All of the forms agree in the possession of a long prehensile tail. Many of them live on young shoots, leaves, and blossoms of the trees they inhabit, while others are insectivorous. The incisor teeth are six in number in the upper jaw and two in the lower, the canines are one on each side in each jaw, the molars four on each side in each jaw, but the premolars, which intervene between the incisors and the true molars, are small and not constant in their number.

The first section of the family embraces four or five sub-genera. Of these *Cuscus* is distributed through all the smaller islands of the Australian group, and one species has lately also been found in New Guinea. Wallace describes these forms as opossum-like animals, with prehensile tail, of which the terminal half is generally bare. They have small heads, large eyes, and a dense covering of woolly fur, which is often pure white, with irregular black spots or blotches, or sometimes ashy brown with or without spots. They live in trees, feeding upon the leaves, of which they devour large quantities. They move about slowly, and are difficult to kill owing to the thickness of their fur and their tenacity of life. A heavy charge of shot will often lodge in the skin and do them no harm, and even breaking the spine or piercing the brain will not kill them for hours. The natives everywhere eat their flesh, and, as their motions are so slow, easily catch them by climbing; so that it is wonderful they have not been exterminated. It may be, however, that their dense woolly fur protects them from birds of prey, and the islands they live in are too thinly inhabited for man to be able to exterminate them. They seem to be known by different names in the different islands. The size of most of the species is about that of a domestic cat. Among the best known species are *C. ursinus*, *C. orientalis*, *C. maculatus* (which is also found in North Australia). *C. vestitus* (lately discovered with the *Acanthoglossus* in the Karon Mountains of New Guinea), and others. *Cuscus orientalis*, also named Valentyn's phalanger, is known as Kapoune to the natives of New Ireland; Coes-coes to the natives of Amboyna. Lesson and Garnot state that they are much sought after by the natives for the flesh, which is very fat; the animals are cooked entire by the natives over peat-coals. They emit a fetid odor, which renders their discovery easy, and their capture is said to be facilitated by the fact that when looked at steadfastly they suspend themselves by the tail and eventually drop to the ground from fatigue.

The vulpine phalanger in its appearance and habits closely approaches the cuscus; it differs, however, in the whole of the tail being hairy, at any rate upon the upper surface. This is referred to in its name, *Trichosurus vulpinus*. It has been described as combining the characters of a squirrel and a fox. Ordinarily its food is of a vegetable nature, and is held between the fore paws in the same way that a squirrel or chipmunk eats an acorn. They may occasionally, however, especially in captivity, eat animal food.

The third sub-genus (*Pseudochirus*) embraces Cook's phalanger from New South Wales, and some species recently found in New Guinea (*P. albertisii*, *P. bernsteinii*).

The fore feet are more distinctly adapted for arboreal purposes than in the other members of the genus; for the two inner toes can be opposed to the three outer ones, a "hand" resulting, in which not only the thumb, but also the index finger is opposable to the others in the action of grasping boughs, etc.

The females bring forth but two young at a time, and carry them for a long time in the marsupial pouch, and after that upon the back, until the little ones can take care of themselves. In captivity they are gentle, but are so senseless and stupid that they possess but little interest. They try to avoid observation as much as possible, burying themselves in the hay of their cages, and rolling themselves into a ball, the head being buried between the hind legs.

The fourth sub-genus (*Dromicia*) embraces certain very small forms, resembling in appearance and habits the dormice among the rodents. Instead of four they have only three true molar teeth on either side of each jaw. The ears are almost naked, are pendant and crumpled in the living state. Waterhouse observed three or four specimens of the common Tasmanian species living in the Zoological Gardens of Lon-



FIG. 12. — *Trichosurus vulpinus*, Vulpine Phalanger.

don. The body is only about three or four inches long, the tail almost as much. The skin of the side of the body is attached to the legs as far as the wrist and ankle-joints, an arrangement which recalls the parachute of the next group. Although it is not so much developed, Gould observes (from the study of some specimens in captivity) "that the habits of the *Dromicia* are extremely like those of the dormouse. They feed on nuts and similar food, which they hold between their fore-paws. They are nocturnal, remaining asleep during the whole day, or if disturbed not easily roused to a state of activity; and coming forth late in the evening, and then assuming their natural rapid and vivacious habits, they run about a small tree which is placed in their cage, using their paws to hold by the branches, and assisting themselves by their prehensile tail, which is always held in readiness to support them, especially when in a descend-

ing attitude. Sometimes the tail is thrown in the reverse direction, turned over the back, or at other times, when the weather is cold, it is rolled closely up towards the under part, coiled almost between the thighs. When eating, they sit upon their hind quarters, holding the food in their fore paws, which, with the face, are the only parts apparently standing out from the ball of fur, of which the body seems at that time to be composed. They are perfectly harmless and tame, permitting any one to hold and caress them without even attempting to bite, but do not evince the least attachment either to persons about them or even to each other."

In a natural state the *Dromicia* appears to prefer the *Banksia* trees, whose blossoms furnish it with a never-failing supply of insects and honey.

In addition to two Australian species, *D. concinna* and *D. neillii*, we have recently been made acquainted with another larger form from the Arfak Mountains of New Guinea. Alphonse Milne Edwards has described this as *D. caudata*. It attains the length of eleven or twelve inches, of which six belong to the tail.

The second section of this family embraces those forms which are provided with a lateral fold of the skin, the "parachute," extending between the fore and hind limbs, as in our flying-squirrels, and serving to prevent the too rapid descent of the creature in the long flying leaps from tree to tree, which form their chief method of moving from place to place. The generic name, *Petaurius*, is given to all of the members of the section, but several sub-genera are distinguished, of which *Petaurista* may be first considered. The largest of the flying-phalangers, *P. taguanöides*, of New South Wales, belongs to this division. The body is as much as twenty inches in length, and the tail even longer. Here the flank membrane only extends to the elbow-joint, and the ears are short, and covered with hair. Like some of the smaller forms, this is much sought after as food by the natives, who surprise them while asleep in trees during the day, and seizing them by the tails, dash their brains out against the stem of the tree. Unless treated in this summary fashion, the phalanger is said to defend itself with teeth and claws in a very able manner.

The genus *Belideus* is distinguished from the above by its long, naked ears, bushy tail, and by the fact that the parachute reaches as far as the outer finger. One of the most widely distributed species is the *Belideus ariel* of North Australia, which also extends into New Guinea, Batchian, and the Aru Islands, and is, perhaps, identical with the *B. breviceps* of South Australia. This species and its congeners, such as *B. sciureus*, the sugar-squirrel of the colonists of New South Wales, possess a great superficial resemblance to the little flying-squirrels of our woods. The body is rarely more than six inches in length, whereas the tail may be more than twice as long. Such is the case in the *Belideus flaviventer* of New South Wales, which Bennett has had an opportunity of studying both in a state of nature and captivity. The fur of this little creature is exceedingly soft, and in color and texture reminds one of chinchilla; it is accordingly much valued by colonists. The flesh is prized as food by the natives, who drag the little creatures by their tails from the forks and holes in the trees in which they sleep during the day. The *Belideus* is entirely arboreal, moving with an awkward waddle upon the ground, but leaping from tree to tree during the night with great alacrity. Very long leaps are effected by aid of the parachute; these are always obliquely downwards, the little creature when pursued making its way to the higher branches of a tree and leaping down to another alternately. It lives upon the honey of the gum-tree blossom, and also upon the tender shoots of these trees.

A third genus of flying-phalangers embraces the very smallest of the marsupials, the

Acrobata pygmæus, or opossum mouse of New South Wales. It is about the size and color of a common mouse, inclining to yellowish white on the under part of the body. It is interesting to note that the teeth of this pigmy phalanger approach the insectivorous pattern.

A form has been described by Prof. McCoy which is allied to *Belideus*, but differs from it in the absence of a parachute or flank membrane. It occurs in the "scrub" on the banks of the Bass River in Victoria. The generic name *Gymnobelideus* has been applied to it.

Elevated to a distinct family by some zoologists, but by others associated with the phalangers, is the very peculiar long-snouted *Tarsipes* (*T. rostratus*) from West Aus-



FIG. 13. — *Belideus sciureus*, Sugar-Squirrel.

tralia, of the general form and size of a mouse; its most obvious distinguishing features are the long, slender-pointed muzzle, and the three dark, longitudinal stripes in its gray fur. The tongue is also very much elongated, and is employed for sucking honey from the flowers of various trees. The *Tarsipes* is also insectivorous; in a minor degree, however, as the rudimentary condition of the teeth proves. These are not very small in size, and separated by gaps, but are not constant in their number. The points in which the *Tarsipes* agrees with the phalangers are the prehensile tail, and the coalesced second and third toes. These toes are armed with claws, but the fourth and fifth have only flat nails, a peculiarity in which *Tarsipes* approaches the *Dromicia* referred to above.

In the two following families, the bandicoots and kangaroos, two tendencies which largely affect the form of the animals are to be observed, viz., one towards the dispro-



Perameles nasuta, bandicoot.



Myrmecobius fasciatus, banded ant-eater.

portionate development of the hind legs, the other towards the disuse of from two to four of the inner toes of the hind feet. In both the gait is consequently peculiar; in the bandicoots it is a combination of running and leaping similar to that of a hare; the kangaroos, on the other hand, where the excessive development of the hind legs is most marked, progress by a series of leaps in which the fore legs take no part at all.

The bandicoots form the fifth family of the marsupials, for which the term PERAMELIDÆ has been selected in reference to the leading genus. Two genera are recognized, *Perameles* and *Choeropus*, which are readily distinguished by the structure of the feet. They agree, however, in their small size, pointed snout, their number of the teeth ($i \frac{5}{3}$, $c \frac{1}{1}$, $p \frac{3}{3}$, $m \frac{4}{4}$), and the fact that the opening of the pouch, which contains eight teats, looks backwards.

The genus *Perameles* includes forms in which the fore feet have five toes, the two inner of these being rudimentary and nailless; the fourth and fifth toes of the hind feet bear the weight of the body, while the second and third joined toes are small. The inner toe may be small—*Perameles* proper—or entirely absent, as in the rabbit-eared perameles (*P. lagotis* from West Australia), sometimes made into a separate subgenus, *Macrotis*, or *Peragulea*, and further characterized by its softer fur from the other bandicoots. These are most largely represented on the Australian Continent, and embrace six or seven species, of which *P. nasuta*, *P. macroura*, and *P. obesula* are the commonest. The bandicoots live in the cooler and more mountainous regions of Australia, and form burrows there in their search for roots and tubers. They are occasionally a great nuisance to the settlers by causing ravages in their potato-fields, and, when they get the chance, by burrowing under the walls of the barns and getting at the grain. In this respect they may be as troublesome as rats, which they resemble in general form and in the length and sparsely-haired character of the tail. They are fortunately not possessed of rodent teeth, however, and are thus comparatively easily kept out of granaries. Unlike the rat, they are excessively timid, but easily reconcile themselves to captivity. Like most marsupials, they are uninteresting as inhabitants of a zoological garden, which is partly attributable to their low intellectual development and partly to their nocturnal habits.

In addition to the species which are found on the continent, several other species have been described from the neighboring islands. Thus, *P. doreyanus* and *longicaudatus* are found in New Guinea, *P. arvensis* in the Aru Islands, and *P. rufescens* in Ké.

The second genus of the family embraces the singular *Choeropus castanotis*, or pig-footed bandicoot from South Australia. It is characterized by very slender legs; the fore-legs have only two toes, the second and third, and the hind-legs only one, the fourth, which bears the weight of the body. The second and third joined toes and the fifth are present, and bear nails, but are quite rudimentary. The habits of the *Choeropus* appear to correspond to those of the ordinary bandicoots, except that it forms a nest for itself among thick underbrush so as easily to escape notice. In size it resembles a small rabbit; its fur is somewhat longer than that of the ordinary bandicoot, and is for the most part of a brownish-gray tint.

In the family which embraces the kangaroos and their allies the difference between the size of the fore and hind legs is usually much greater than in the bandicoots: to this peculiarity the group owes its name, MACROPODIDÆ. Of all the marsupial families this includes not only the largest forms, but also the greatest number of genera and

species, and is, further, that which has the widest geographical range. The following may be regarded as the most important anatomical characteristics of the group. The dental formula is, $i \frac{3}{3}, c \frac{0}{0}, p \frac{1}{1}, m \frac{4}{4}$. Of the upper incisors, the foremost are the largest; the two lower incisors are chisel-shaped and project horizontally forwards from the jaw. Occasionally the premolars are strikingly large. In contrast to other marsupials there are generally well-developed eyelashes. The innermost toes of the hind feet are absent, while the second and third are much reduced in size, and included in the skin as far as the last joints. The contiguous surfaces of the claws of these toes are flattened, but the inner claw is convex on its inner side, and the outer convex on its

outer side. Of the fourth and fifth toes, which chiefly bear the weight of the body, the former is considerably the larger. The stomach, in accordance with the truly herbivorous habits of the animals, is much elongated, and sacculated after the fashion of the large intestine.

An account of the appearance and habits of the giant kangaroo (*Macropus major*) may serve as an introduction to the natural history of this large and important family.

This species was discovered by Cook little more than a century ago on the coast of New South Wales. At that time abundant, it has been gradually driven further into the interior through persistent hunting, both by natives and colonists. Although for the most part found in open places, browsing on the herbage and bushes, it retires during the summer and during the heat of the day to any shelter in its vicinity. The kangaroo has generally been described as a social animal, but it is probable that the families seen feeding together in herds are rather attracted by the abundance of food in particular places

than by each other's society. The disproportionate development of the hinder part of the body makes the usual movements somewhat awk-

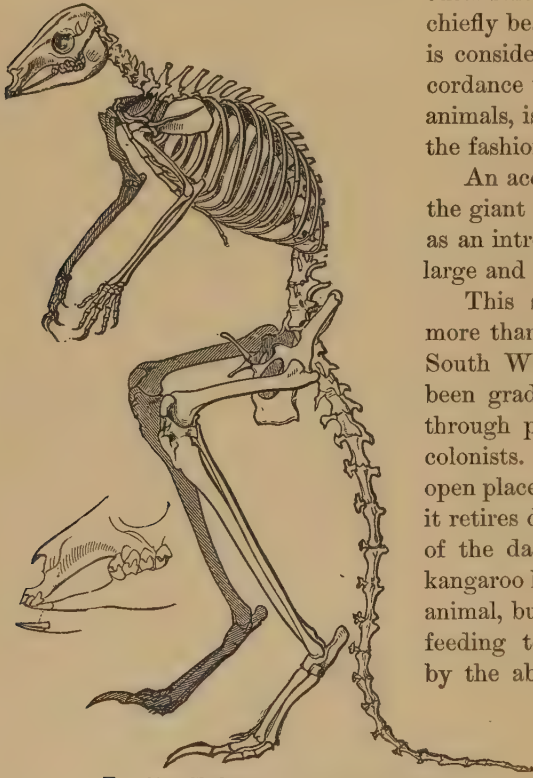


FIG. 14. — Skeleton of *Macropus major*.

ward, but when in full flight its leaps — often fifteen or twenty feet — are described as very graceful.

Two common attitudes in rest are illustrated in the plate. One member of the family, often a male, squats on the ground supporting itself on its tail and elongated ankle-bones, while the others lie about or browse at their ease, then commonly applying their fore feet to the ground, till they receive the danger signal from their sentinel. Like the other species the giant kangaroo is exceedingly timid. In captivity it has been known to die of sheer fright, and in freedom it is very readily alarmed by any unfamiliar sight, sound, or smell, immediately raising itself upon tail and hind limbs as on a tripod.

The natives generally hunt the kangaroo by forming a circle round the herd, and then killing them with clubs. By the colonists they are generally driven towards a par-



Macropus major, giant kangaroo.

ticular spot, where the sportsmen have been stationed beforehand, after the fashion of a battue, but they are also stalked, and occasionally hunted by dogs something like fox-hounds. Although so timid, the kangaroo, at close quarters, and especially when wounded, may turn out to be an enemy not to be despised. A blow from the tail or hind leg is sufficiently severe, but the dogs are very often torn open by the strong claws of the hind feet. Especially when it has taken to water is it able to defend itself against dogs, for its high stature enables it to stand out of the water, while the dog is held under by the fore paws.

The males especially attain a high stature, often seven feet in their ordinary erect position, while the females are on an average a third smaller.

The general color of the abundant hair is brownish-yellow, paling on the under parts and limbs, but darkening considerably on the tail. Our figure of the skeleton, Fig. 14, exhibits well the proportions of the limb-bones, the strength of the tail-vertebræ, the epipubic bones, jutting out in front from the pelvis, and the peculiar character of the dentition. The dental formula is $i \frac{3}{1}, c \frac{0}{0}, p \frac{1}{1}, m \frac{4}{2}$, and a considerable gap exists between the incisors and molar teeth. The shape and direction of the lower incisors is very characteristic; associated therewith is a peculiarity in the structure of the lower jaw which deserves to be referred to at some length.

The two halves of the lower jaw are joined in front in such a manner as to permit a separation of the two long incisor teeth. This is taken advantage of by the animal in grazing; the grass is seized between the sharp inner margins of these teeth, and is clipped off as by a pair of shears. This is accompanied by a forward movement of the head, terminated by a slight lateral jerk. In some of the large forms an interval of $\frac{1}{4}$ inch may thus be formed between the incisors. The external edges of these teeth are likewise sharp, and this lateral movement serves to bring them close up to the upper incisors, between which and them there is otherwise a gap on either side. It appears that an African rat shares this peculiarity of the kangaroos. An explanation of this form of lower jaw has been offered by Mr. H. W. Blundell in a letter to *Nature*:—

“The great plains and deserts over which these marsupials wander in search of food afford an exceedingly precarious supply of pasture in consequence of droughts and bush-fires, which not unfrequently follow a superabundance of herbage. These animals, by means of their procumbent teeth, which they make use of as shears, are thus enabled to cut off any green roots or half-buried remains spared by a scorching sun, and obtain nourishment where any grass-feeding placental animal would certainly starve. It is in consequence, I believe, of the power which is by this means given to these marsupials, that in the great pastoral districts of New South Wales and Queensland it has been found that they are far more destructive of food than any stock that can be put upon the land. And in places where wallabies and pademelons are exceedingly numerous it is noticed that the native grasses in the particular localities which they frequent become completely destroyed, and that such places remain ungrassed until fresh seed is scattered over them by the winds.”

The characteristic locomotion of the kangaroos is well described by Brehm. In leaping, the fore limbs are tightly clasped against the chest, the tail stretched straight backwards, while the powerful thigh-muscles are caused suddenly to straighten the joints, by which action the body flies through the air in a low curve. In ordinary locomotion the leaps are only nine or ten feet, but when alarmed the animal doubles or even trebles its exertions. The right foot seems to be employed more than the left, and is held a little in front of that. With each leap the tail swings upwards and

downwards; it is not employed in changing the course of the animal, but this is always effected by two or three short leaps. In locomotion its fore limbs are never lowered, and in fact only the toes of the hind limbs touch the ground. In open ground it is more than a match in swiftness for the fleetest dog, and can keep up its swiftest pace for hours; when there is any cover it has immeasurably the advantage by clearing clumps of shrubs six or eight feet high; on uneven ground, on the other hand, it is at a disadvantage, especially down hill, for it is liable to slip and roll over on reaching a sloping surface. We shall find that the rock-kangaroos are better able to cope with these unfavorable circumstances.

The coloring of the giant kangaroo as described above may vary into paler yellow and into darker, almost sooty hues. These varieties have occasionally been accorded the value of species, but it is probable that they are brought about by local influences. Some members of the genus, however (which have been separated under the sub-genus *Onychogalea*), present peculiarities of more importance: these are small, graceful, and prettily-colored forms (*M. unguifer*, *M. fraenatus*, *M. lunatus*), in which the end of the tail is provided with a horny excrescence something like a nail. Until lately it was thought that the genus *Macropus* was confined to Australia and Tasmania, but recent investigations have brought to light species from New Guinea and the smaller islands of the Austro-Malayan group. Such are *M. brunii* from Aru and Ké, *M. papuanus* from eastern New Guinea, *M. browni*, a sad-colored species from New Ireland.

To the genus *Halmaturus* (characterized by the absence of hair on the muffle) belong by far the greater number of species of this family. They do not live on open ground like the species of *Macropus*, but inhabit country more or less thickly covered with shrubs. Some of them are of large size, such as the Antelope kangaroo of North Australia (*H. antilopinus*), in which the hairs are stiff and applied to the body as in a deer's skin, and Bennett's kangaroo, the Brush kangaroo of the Tasmanian colonists (*H. Bennetti*), which is of considerable value, both for its flesh and hide; others again, the true wallabies, are of small size, but are regarded as very valuable game. Such are the pademelon wallaby of New South Wales (*H. thetidis*), and the wallaby of Tasmania (*H. billardieri*), a form which lives in herds of hundreds in the scrub of the interior of Tasmania. A species of *Halmaturus* has recently also been found on New Guinea.

The genus *Petrogale* includes forms fitted for living in rocky districts. The hind legs are shorter, as are the nails of the toes. The under surface of the foot is covered with horny tubercles, which are evidently of service in keeping the animals from slipping; and the tail, although used in balancing the body, does not support its weight as in the other forms. The type of this group has a well-marked brush at the end of its tail, whence its specific name *P. penicillatus*. Some seven species of rock-kangaroo have been described, all from Australia.

The so-called Hare-kangaroos, *Lagorchestes*, live upon the open plains, and have the muffle hairy, like *Macropus*. In size, color, and habits they greatly resemble the hare, making like it a "form" in the grass, and being exceedingly fleet. One of the species found in islands on the west coast, *L. fasciatus*, retires in danger to galleries made in the Mimosa "scrub" by cutting away the lower branches and spines. It is almost impossible to procure them from these retreats.

The second section of the kangaroo family embraces natives of New Guinea and Mysol. The best known species is *Dorcopsis luctuosa*, which was living for some time in the Zoological Gardens in London. It is a sad-colored form of small size, the fur,

except on the belly, being ashy-brown. On the nape of the neck the hair is directed forwards, a peculiarity which is presented by all the members of this section. The body is about two feet, and the tail one foot in length; the latter is covered with blackish hair, except for one and one-half inch at the tip, which is naked and scaly on the under surface; a condition due to the fact that this part is used as a method of support. The Mysol species (*D. muelleri*) is more of a chocolate-hue. The presence of upper eye-teeth as well as the large size of the premolars is sufficient to distinguish the skulls of these forms from the ordinary kangaroo's. The stomach also differs from that of the kangaroo, in being lined by ordinary gastric glands.

The tree-kangaroos, which form the genus *Dendrolagus* (*D. ursinus* and *inustus*), while agreeing with the ground-kangaroos of the same region in the anatomical char-



FIG. 15. — *Halmaturus thetidis*, pademelon.

acters referred to above, differ from them markedly in their habits and in certain modifications of form due to these. The tail no longer serves as a prop, consequently it is not so robust; the fore legs are longer in proportion to the hind, and are armed with more powerful claws, by which they are enabled to grasp the bark and branches in climbing. They move on the trees by a series of short jumps with the hind feet, which are, however, by no means so well adapted to an arboreal life as the same parts in the phalangers. Wallace considers that the tree-kangaroos have been modified from ground forms to enable them to feed on the foliage in the vast forests of New Guinea, as these form the great natural feature which distinguishes that country from Australia.

The sub-family Hypsiprymninae includes the *Kangaroo-rats*, or *Potoroos*, usually of about the size of a rabbit, and differing from the true kangaroos not only in their anatomical peculiarities, but also in their habits and appearance. They feed on roots, which they dig up with their fore feet, the three middle toes of which are elongated

for this purpose. *Hypsiprymnus murinus*, a native of New South Wales, is the type of the long-faced genus; the fur is long and somewhat coarse, the tail completely rat-like in its character (Fig. 16). Of the short-faced forms, *Bettongia cuniculus*, the Tasmanian kangaroo-rat is one of the best known; while the third genus, *Æpiprymnus*



FIG. 16. — *Hypsiprymnus murinus*, kangaroo-rat.

was formed by Garrod to include one of the largest forms, the red kangaroo-rat of New South Wales (*Æ. rufescens*). This species somewhat resembles the hare-kangaroos in its habits, is pursued by the natives for food, and although very fleet, is easily taken on account of its habit of taking shelter in hollow logs.

The last family of the Australian marsupials, the *DASYURIDÆ*, differs from all the other groups living in the same geographical region in the character of the dentition, which is unquestionably of either carnivorous or insectivorous type, and in the fact that the second and third toes of the hind feet are perfectly free from each other. Next to the *Macropidæ* this family is the richest in genera and species.

Of the genera, *Myrmecobius*, which only includes a single species, the banded ant-eater (*M. fasciatus*) is one of the most interesting on account of the great number of its teeth (the formula is $i \frac{4}{3}, c \frac{1}{1}, m \frac{8}{3}$), and the absence of a pouch. Both of these peculiarities seem to point to the fact that it is an archaic form, a view which is supported by the dentition of the earliest marsupial fossils.

The ant-eater is a native of the west coast of Australia. It is of about the size of a squirrel, and is at once recognized by its peculiar coloring. The anterior part of the body is reddish, the posterior black, and this part is traversed by six or more white vertical bands. The feet and claws are short and stout, evidently adapted to scratch open the ant-hills in the vicinity of which the creature lives; while the tongue, as in the echidna, is long and slender, and serves to attach to itself the insects which are afterwards ground down between the prickly cusps of the grinders. The ant-eater is one of the most harmless of the *Dasyuridæ*, but is not easily kept in captivity on account of the difficulty of supplying it with a proper quantity of suitable food.

The smallest members of the *Dasyuridæ* are certain insectivorous animals, resem-

bling mice in coloring, form, and size, and which form four nearly-related genera: *Phascologale*, *Antechinus*, *Podabrus*, *Antechinomys*. The first-mentioned genus includes the largest species (*Ph. penicillatus*) which attains the size of a squirrel, and possesses a long tail of which the greater part is bushily-haired. In *Antechinus* (*A. apicatus* and *flavipes*) the tail is clothed with short hairs throughout, and there is an indication of a pouch. *Podabrus* again has the tail thickened at the base.

Another curious member of this group is a recently discovered form, *Antechinomys lanigera*, from East Central Australia. The body is little more than three inches in length, while the tail (the tip of which is provided with a woolly tuft) measures almost five. The general color of the fur is mouse-gray, the belly, however, being white; a naked space surrounds the teats, which are not very distinct, and in this case also the skin is not turned into a pouch.



FIG. 17. — *Dasyurus ursinus*, Tasmanian devil.

The largest as well as the most truly carnivorous members of this family are the species of *Dasyurus* and *Thylacinus*. To the former genus belong certain forms which, both in size and general appearance, have much superficial resemblance to the weasels and martins of Europe and America. They are distributed throughout all Australia and Tasmania. Some of the smaller ones, like the last group, possess a small inner toe on the hind foot, but the best known form, the Tasmanian devil, Fig. 17 (*D. ursinus*), is destitute of that, and is consequently regarded as the type of a sub-genus (*Sarcophilus*). In size, the Tasmanian devil approaches the badger; in the form of body, relatively large size of head, and texture of the fur, it is more bear-like. The color is deep black, with the exception of a white band on the neck and two white spots on the sides; occasionally another white band is present on the rump.

In accordance with its carnivorous habits the dentition is somewhat formidable; its formula is $i \frac{3}{3}$, $c \frac{1}{1}$, $p \frac{2}{2}$, $m \frac{4}{4}$. According to Mr. Harris, the original describer of this species: "These animals were very common in our first settling at Hobart Town, and

were particularly destructive to poultry, etc. They, however, furnished the convicts with a fresh meal, and the taste was said not to be unlike veal. As the settlement increased, and the ground became cleared, they were driven from their haunts near the town to the deeper recesses of the forests yet unexplored. They are, however, easily procured by setting a trap in the most unfrequented parts of the woods, baited with raw flesh, all kinds of which they eat indiscriminately and voraciously; they also, it is probable, prey on dead fish, blubber, etc., as their tracks are frequently found on the sand of the sea-shore. In a state of confinement they appear to be untamably savage, biting severely, and uttering at the same time a low, yelling growl. A male and female,



FIG. 18. — *Thylacinus cynocephalus*, pouched dog.

which I kept for a couple of months chained together in an empty cask, were continually fighting; their quarrels began as soon as it was dark (as they slept all day), and continued through the night almost without intermission, accompanied by a kind of hollow barking not unlike a dog, and sometimes a sudden kind of snorting, as if the breath was retained a considerable time and then expelled. They frequently sat on their hind parts, and used their fore paws to convey food to their mouths. The muscles of the jaw were very strong, as they cracked the largest bones with ease."

The Tasmanian devil is a frequent inmate of menageries and zoological gardens; it never becomes reconciled to its captivity or keeper so as to lose its characteristic ill-nature, and as it cowers away from the light in the darkest corner of its cage during the day, it is no more interesting than most of the nocturnal marsupials.

The remaining genus, *Thylacinus*, includes only one species, the zebra-wolf, or pouched dog (*T. cynocephalus*, Fig. 18), likewise a native of Tasmania. In size it is equal to a wolf; the head, as its specific name indicates, is dog-shaped, the muzzle being much longer than in the Tasmanian devil; the fur is short and applied to the skin, its color a grayish-brown. It owes its name, zebra-wolf, to twelve or fourteen black stripes which run transversely across the back and rump. In its nocturnal habits, and the character of its food, it resembles the Tasmanian devil, and like it, has been to a large extent exterminated by traps on account of its ravages on sheepfolds and poultry-yards. It lives in less accessible places than that species, and is consequently rarer in captivity, although when secured it conducts itself in a very similar fashion. Its sensitiveness to light is evident by the constant working of the third eyelid or nictitating membrane, which can be drawn like a screen over the surface of the eyeball. Unlike the rest of the marsupials, the epipubic bones are only in a cartilaginous condition; further peculiarities, which have been already referred to, are the rudimentary pouch possessed by the male Thylacine, and the far-back position of the aperture of the pouch in the female.

Although the pouched dog is at present entirely confined to Tasmania, fossil remains of the genus have been found in caves in Australia, so that it is likely that the essentially carnivorous marsupials had at one time a very much wider distribution than they have at the present day.

Reference has already been made to the doctrine that existing monotremes and existing marsupials must in no wise be regarded as occupying a place in the direct line of descent of the higher mammals from the lower vertebrates. As Prof. Huxley has remarked, they ought only to be regarded as representative forms of the groups that occupied that position. From the study of comparative anatomy it is possible, however, to recognize what characters are due to modification, and what characters must have been possessed by progenitors of existing forms. Dr. Gill has accordingly employed the terms *Prototheria*, *Metatheria*, and *Eutheria* to designate those stages of evolution which are represented at the present day by the sub-classes, Ornithodelphia, Didelphia and Monodelphia. The Metatheria must have possessed, in common with the Prototheria, epipubic bones, and a small corpus callosum, and like them, must have been characterized by the want of that mode of nutrition of the fœtus in the womb which is found in the higher animals, the "allantoic placenta." They must have possessed, however, in common with the higher animals, which descended from them, a complete double dentition, and unmodified five-toed feet, while they probably did not bring forth their young earlier than existing carnivores and rodents do. No remains have yet been found to which these characters can be attributed; all, even the earliest, are distinctly *marsupial*.

The earliest mammalian remains that have been detected in America consist of a lower jaw with teeth (three incisors, one canine, and ten molars), from beds of triassic age in North Carolina — the genus *Dromatherium*. In the number and pattern of its molars it resembles more closely the banded ant-eater (*Myrmecobius*) than any other existing marsupial.

The only jurassic mammalian remains found in this country, consisting of lower jaws and teeth, have been described from the Atlantosaurus beds in the Rocky Mountain region by Prof. O. C. Marsh. He regards them as belonging to animals allied to the existing opossums, but of considerably smaller size, and probably insectivorous in their

habits. That most nearly related to the opossum he has named *Dryolestes*, but representatives of two other families have been found more nearly related to fossils occurring in beds of the same age in England. These he has named *Thylacodon* and *Tinodon*.

In more recent formations, both in North and South America, fossils have been found referable to the same genus as the existing opossums of these regions.

By far the greater part of the fossil marsupials of Australia are of comparatively recent origin, and have been found in bone-caves in various parts of the continent and in beds of tertiary or post-tertiary age. Many of them are of gigantic size, and most are referable to existing families.

As already indicated, page 28, Gerard Krefft has pointed out that all the Australian marsupials, extinct and living, are evidently offshoots of a kind of animal which combined the dental characters of both carnivorous and herbivorous marsupials. The *Thylacoleo*, which attained the size of a lion, was the last representative of this original form, its grinders being decidedly carnivorous in form, while the other teeth point to a herbivorous mode of life. Krefft believes that from such a form as this the living marsupials were developed in two directions; the one line resulting in the forms which possess two conjoined inner toes (the kangaroos, kangaroo-rats, wombats, phalangers, and bandicoots), the other culminating in the true flesh-eaters without the conjoined inner toes (the Tasmanian devil, dasyures, pouched mice, etc.). The native bear he regards as the most ancient of living marsupials, and a diminutive representative of the gigantic *Diprotodons* and *Nototheria*, which are generally referred to the kangaroo family. An idea of the size of the *Diprotodon* may be formed from the fact that its skull was three feet in length.

In his geographical distribution, Wallace offers some explanations of the causes of disappearance of these large marsupial forms from the surface of the earth: "This can hardly have been due to the glacial epoch, for no very extensive glaciation could have occurred in a country like Australia; but if the ocean sank two thousand feet, the great eastern mountain range might have given rise to local glaciers. It is, however, almost certain that during late tertiary times Australia must have been very much more extensive than it is now. This is necessary to allow of the development of its peculiar and extensive fauna; especially as we see that that fauna comprised animals rivalling in bulk those of the great continents. It is further indicated by the relations with New Guinea and the character of the fauna of the Australian region. The lowering of the ocean during the glacial period would be favorable to the still further development of the fauna of such a country; and it is to the unfavorable condition produced by its subsequent rising, equivalent to a depression of the land to the amount of two thousand feet, that we must impute the extinction of so many remarkable groups of animals. It is not improbable that the disappearance of the ice, and the consequent (apparent) subsidence of the land, might have been rapid as compared with the rate at which large animals can become modified to meet new conditions. Extensive tracts of fertile land might have been submerged, and the consequent crowding of large numbers of species and individuals on limited areas would have led to a struggle for existence, in which the less adapted and less easily modifiable, not the physically weaker, would succumb.

"There is, however, another cause for the extinction of large rather than small animals whenever an important change of condition occurs. It is dependent on the fact that large animals as compared with small ones are slow breeders, and as they also

necessarily exist in much smaller numbers in a given area, they offer far less materials for favorable variations than do smaller animals.

"In such an extreme case as that of the rabbit and elephant, the young born each year in the world are probably as some millions to one; and it is very easily conceivable that in a thousand years the former might, under pressure of rapidly changing conditions, become modified into a distinct species, while the latter, not offering enough favorable variation to effect a suitable adaptation, would become extinct. We must also remember the extreme specialization of many of the large animals that have become extinct — a specialization which would necessarily render modification in any new direction difficult, since the inherited tendency of variation would probably be to increase the specialization in the same directions, which had heretofore been beneficial. If to these two causes we add the difficulty of obtaining sufficient food for such large animals, and perhaps the injurious effects of changes of climate, we shall not find it difficult to understand how such a vast physical revolution as the glacial epoch, with its attendant phenomena of elevations and subsidences, viz., winds, and sudden floods by the bursting of lake-barriers, might have led to the total extinction of a vast number of the most bulky forms of Mammalia, while the less bulky were able to survive, either by greater hardiness of constitution or by becoming more or less modified. The result is apparent in the comparatively small or moderate size of the species constituting the temperate fauna in all parts of the globe. It is much to be regretted that no mammalian remains of earlier date have been found in Australia, as we should there see if it is really the case that marsupials have always formed its highest type of mammalian life. At present its fossil fauna is chiefly of interest to the zoologist, but throws little light on the past relations of this isolated country with other parts of the globe."

As in North America so in Europe, the earliest known mammalian remains have been found in beds of triassic age, and although consisting merely of teeth, evince marked marsupial characteristics, and indeed have been compared to those of the banded ant-eater in their form.

Both in the lower and upper oolitic strata, numerous lower-jaws with teeth have been found, which are also interpreted as belonging to insectivorous marsupials, the grinding teeth being numerous, and provided with sharp cusps. Among the earliest forms are *Phascolotherium*, *Amphilestes*, *Amphitherium*; among the later, *Spalacotherium* and *Triconodon*. It is interesting to note the similarity of these forms with the fossils of the same age, recently described by Prof. Marsh. With the beginning of the Tertiary period, the marsupials seem to have disappeared from Europe. A well-preserved skeleton of an opossum-like form was, however, found by Cuvier in eocene strata near Paris, and referred in fact by him to the same genus as the American opossum, from which, however, it has recently been separated as *Peratherium*.

R. RAMSAY WRIGHT.

SUB-CLASS III.—MONODELPHIA.

All of the remaining groups of Mammals are united in a single sub-class, which may be distinguished from the two preceding divisions of the same rank by the presence of a true allantoic placenta, a single termination of the oviduct, and a higher grade of nervous system, the brain being usually larger, the corpus callosum better developed, and the anterior commissures reduced in size. Marsupial or epipubic bones are never found, though in some Carnivora there are small cartilages which appear to represent them. The twelve orders of Monodelphia naturally fall into two divisions. The first, Ineducabilia, comprising the edentates, rodents, insectivores, and bats, being characterized by a relatively small and smooth cerebrum, which does not cover either the olfactory lobes nor, completely, the cerebellum. The other division, Educabilia, has a large and convoluted cerebrum, covering, or nearly covering, the olfactory lobes in front and the cerebellum behind.

ORDER I.—BRUTA, OR EDENTATA.

Scattered over various tropical portions of the globe are several minor types of mammals of a low grade of organization and characterized by peculiarities of form or strange modifications of the dermal investiture. South America is especially rich in

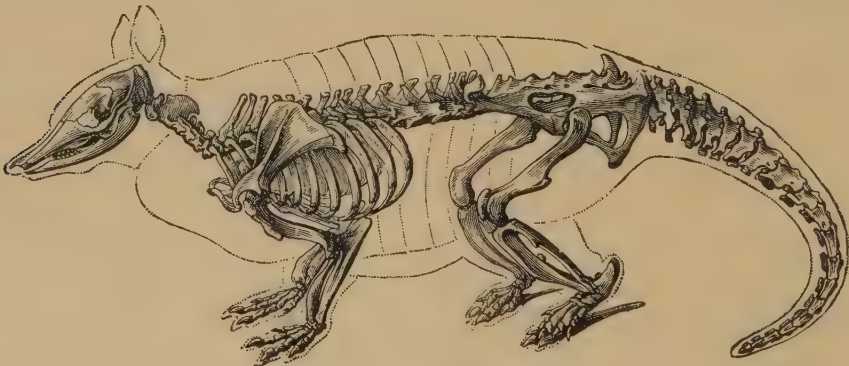


FIG. 19.—Skeleton of *Tatusia*.

such types, and on that continent are found the armadillos and pichiciagos with their shell-like covering, the typical ant-eaters, and the sloths whose habits have obtained for them their proverbial name. Outside of America, Africa nourishes two strange types—the pangolins, with a development of the dermal appendages simulating a pine-cone, and animals having a superficial resemblance to the hog, but whose peculiarities of organization ally them to the pangolins. India shares with Africa the pangolin type; but elsewhere than in the regions mentioned are found no close relations. These various forms are so unlike in appearance, as well as in several other respects, that it is not to be wondered at that their relationship to each other has been doubted and disputed. Nevertheless, the more closely they have been studied the more evident becomes the truth that they form a natural group as contradistin-

guished from other animal types. That group has been credited with ordinal value, and was first recognized as a whole by Cuvier, who gave to it the name Edentata, or the Toothless Animals. But long before Cuvier's time, Linnæus had constituted a group, which he named Bruta, for mammals destitute of incisor teeth, and such want of incisive teeth is the most striking superficial characteristic of the animals in question. It is true certain other animals are devoid of incisor teeth, and Cuvier especially sinned in the inclusion, on that account, of two types—the Australian duck mole and Echidna—which differ more from the forms enumerated than do any other mammals. But the ant-eaters and pangolins are pre-eminently the mammals destitute of front as well as other teeth, and may therefore with strict propriety retain the name Bruta as their ordinal designation, and with them are to be associated the sloths, armadillos, etc.

All these forms are ineducabilian placentiferous mammals, with a relatively small and unilobate cerebrum; the members formed for progression by walking or crawling; the carpal and tarsal bones variously developed; the propodial bones distinct; the hind limbs normally related to the pelvis; and the teeth variously developed, often absent, and always deficient in true incisors.

Some remarkable characteristics are developed in representatives of the order, and such as are not paralleled in any other order of mammals. In two groups a peculiar dermal armor is found, but this covering is very different in the respective types, and must have been developed independently; the armadillos exhibit one condition and the pangolins another. The other edentate sub-orders show no approach to such armature, but hair is the sole covering, as in ordinary mammals. Another noteworthy peculiarity is a condition which may be called club-footedness. There is a tendency to this in most of the types, but it is carried to an extreme in the ant-eaters, and the sloths exhibit a modification of the condition which forbids regular progress on land.

In no natural order of mammals is so great a variation exhibited as to various other characters. The placenta, so distinctive for most other groups, here fails in generality, and each great sub-division manifests more or less important peculiarities. The best course, then, is to review the various forms first and to generalize the results of the examination afterwards.

The American forms first demand our attention. These are at once recognizable as divisible into three categories, by external as well as internal peculiarities, and have been severally designated as sub-orders, named Loricata, Tardigrada, and Vermilingua.

SUB-ORDER I. — LORICATA.

The Loricates are all those American edentates which are known as armadillos, but which, differing greatly in structure, are segregated under three primary sub-divisions, which may be called families. The scientific as well as popular names of the sub-order have reference to the most prominent external character—the development of a *quasi* coat of mail in the form of a carapace, which covers all the back, leaving only the head (but not always) and tail exposed from above. This carapace is the result of a peculiar ossification of the dermal investiture, and is formed by the coalescence of numerous small scutes. It may be entire, but in the living types is resolvable into three more or less well-defined regions,—an anterior, a posterior, and an entire or variously divided median portion. To such an extent is this sometimes divided into

zones that the animal is capable of rolling itself into a ball, and thus, by means of the carapace, covering the body; the upper surface of the head, and generally the tail, are also more or less shielded by analogous ossifications, and so likewise are the legs. The inferior and less exposed parts are, however, covered with hair, as usual in mammals, and hair also is manifested between the joints of the osseous plates, or zones. Teeth are always developed, but in greatly varying number, although approximately equally numerous in the opposite jaws. Generally, however, there are from seven to nine teeth on each side in each jaw, but in the genus *Priodontes* there are from twenty to twenty-five, and consequently they may reach the full number of one hundred in all. These teeth are usually confined to the sides, and in the upper jaw to the supramaxillary bones, and only in *Dasypus* proper do they encroach on the intermaxillary and assume the position of incisors. In form they are sub-cylindrical, and appreciably distant in most, but in *Priodontes* they are compressed and closely approximated. In the aberrant *Priodontes*, too, they have truncated summits; but in the others there is a median transverse ridge with sloping fore and aft surfaces resulting from the alternation of the teeth of the respective jaws, and the consequent wearing of the crowns. Dentine is the chief constituent of the teeth, but an external layer of cement is developed. As usual in the order, the teeth are generally monophyodont (without successors or predecessors), but in one type (the Tatusiids) they are truly diphyodont, all the teeth of the adult, save the very hindmost, having milk or deciduous predecessors, and in the same group an enamel-organ at least is connected with the teeth. The legs have the first joints enclosed in the abdominal integument; the toes are five in number on the hind feet (which are plantigrade), but vary in the fore; the latter are pre-eminently adapted for digging, and all the members of the group are famous burrowers. Although a number of species can run quite rapidly, it is with a shuffling gait, and some exhibit a curious aspect in progression, advancing, as they do, on tip-toe, or rather tip-claw, with their fore feet.

The placenta is oval or discoidal. In *Tatusia*, Alphonse Milne-Edwards found "four fetuses contained in a common chorion, attached to a single placenta of a zonary form, apparently the result of the coalescence of originally distinct placentæ."

The TATUSIDÆ are those armadillos which have the fore toes nearly symmetrically developed, the second and third being longest and sub-equal, and the first and fourth also sub-equal, and but moderately shortened; the metacarpals and phalanges are also moderately developed in due proportion, and all distinct; the fifth toe is obsolete; the head is narrow and the ears close together; the shield has the anterior and posterior portions as well as median zones well defined.

It is to this family that the only armadillo which extends into the United States—the *Tatusia novemcincta*, or *Peba*—belongs. This species is the most extensively distributed of the loricates, ranging from Texas in the north to Paraguay in the south. It attains a total length of about thirty inches, of which the tail forms rather less than half. The dorsal shell has generally eight or nine bands, but sometimes (in the young) as few as six, and the old names, *Dasypus septemcinctus*, *octocinctus*, and *novemcinctus*, express such variations in number. The *peba* affects open lands and plantations, and seeks its food chiefly in the night-time. It is quite indiscriminate in its diet, but is disposed to take it into its burrow and there eat it at leisure. It is more prolific than the armadillos of the *Dasypodid* and *Chlamyphorid* groups, having sometimes as many as ten at a birth, although it has only four teats, and consequently death from starvation

is imminent to some of the brood. Notwithstanding its indiscriminate diet, it is esteemed for its flesh, and is extensively hunted where it dwells. It is chiefly roasted in its shell, and is claimed to surpass roast pig in delicacy.

Its own appetite and preference for ants are sometimes made use of, as in Nicaragua, the animal becoming partially domesticated and indefatigable in keeping down the insect nuisances.

The burrows which it constructs are simple holes, six or seven feet in depth. The opening is circular, and varies in diameter from eight inches to two feet, according to the size of the animal inhabiting it. The direction of these burrows varies considerably, but usually they begin beside some root, going at first directly downward, and then pursuing a course more or less oblique, or even approaching the horizontal. In such burrows most of the time of the peba is spent.

According to Azara, the Brazilians put the carapace of this and other species of armadillos to a peculiar use; cleaning out the flesh, etc., the hardened walls form the body of a primitive guitar. Another musical instrument is furnished by the Kabalasou, its tail being used by the Botocudos of Brazil as a trumpet.



FIG. 20. — *Tatusia novemcincta*, Peba, six-banded form.

Several species have been distinguished by Dr. Gray as very nearly related to the nine-banded armadillo, but several at least require verification. There are, however, other species of the genus quite distinct from the type — one found on the Pampas of temperate South America, *Tatusia hybridus*, the mule armadillo (so-called because of its long ears), and the *Tatusia kappleri* of Surinam and Ecuador.

The typical armadillos, forming the family DASYPODIDÆ, have the toes of the fore feet variously modified and disproportioned to each other; the second toe is the longest

(but not necessarily the stoutest), and the third as well as fourth and fifth are variously shortened; the head is broad behind, and the ears far apart; the dorsal shield differs in different groups. The most striking modifications are manifested in the following types:—

The Encouberts, or Dasypodines, have the first to third metacarpals regularly graduated, and the third longest, but the fourth and fifth are much abbreviated; the third to fifth digits have each the usual number (three) of phalanges, but they are much abbreviated; the anterior and posterior bucklers are well differentiated; the tail has a zoned sheath; and the teeth are in moderate number ($\frac{3}{1}$ on each side). Some four species of this type have been discriminated and referred to two genera — *Dasypus* and *Euphractus*.

The Peludo, or *Dasypus villosus*, is common in the Argentine Pampas as well as Chili, and its habits were early studied by Darwin. It is not an exclusively nocturnal animal, but moves about in the daytime as well. It does not excavate burrows to live in, and shuns damp localities, affecting dry upland plains. Among other food it regales itself on the carcasses of fallen animals, and will burrow, for example, into the body of a horse, and therein satiate itself. Its own flesh is esteemed as superior to beef or veal, and is prepared by roasting, but it is sometimes so fat as to pall the appetite.

The Kabassous, or Xenurines, have the third as well as the fourth and fifth metacarpals abbreviated and broad, and the proximal phalanges are suppressed or united with the metacarpals, while the distal phalanx of the middle digit is much enlarged, and those of the fourth and fifth not very much smaller; the bucklers are more zoniferous than the Dasypodines, and the tail is almost naked; the teeth are in normal number ($\frac{3}{1}$ on each side).

The species of this division — *Xenurus unicinctus*, and *X. hispidus* — inhabit tropical South America, and burrow with great facility.

The Kabalassous, or Priodontines, exhibit a still further deviation from the type in the structure of the fore feet; the metacarpals and proximal phalanges of the three outer (third to fifth) toes being more abbreviated, and, conversely, the last or ungual phalanx of the third toe more enlarged; the anterior and posterior bucklers have much the appearance of the intervening rings, which are numerous (12 to 13), and the tail has alternating rings of small plates; the teeth are very numerous ($\frac{2}{1}$ - $\frac{2}{1}$ - $\frac{2}{1}$ on each side), exceeding those of any other mammals, except some cetaceans.

But one species of this group is known, — *Priodontes gigas*, — which, as its name indicates, is comparatively large and surpasses any other member of the family, sometimes attaining a length of nearly five feet, of which the tail constitutes less than a third. It resides in the forests of Brazil and neighboring states. Its power of burrowing is proportioned to its huge claws, and as it intrudes on the graves of buried natives and travellers, it is looked upon with a certain aversion. It feeds upon carrion as well as insects, roots, and the fruit that has fallen within its reach.

The Apars, or Tolypeutines, exhibit the extreme of modification in the family. In the fore feet the two outer toes are much reduced or obsolete, while the third is extremely large and armed with a long claw; the anterior and posterior bucklers are expanded towards each other, and the intervening rings are few; the tail is short and provided with alternating rows of plates; the teeth are large and few.

The species of this sub-family are few in number, and inhabitants chiefly of the Argentine Republic and Bolivia. They are of small size, and are remarkable for their

ability to roll up into a spheroidal form. Thus curled up, a vertical elliptical aperture occurs at one place, resulting from the anterior and posterior sinuses of the scapular and pelvic shields respectively, but this is mostly closed by the upper surface of the withdrawn head, and the tail is folded under the latter. They are also especially noticeable for the extent to which they progress on the tips of their enlarged fore claws; but this peculiar movement does not render them slow-footed, and they are indeed among the most active and vivacious of the family. Like their larger fellows, they are omnivorous, but in captivity they are chiefly fed on raw meat, boiled eggs, and bread and milk. The longest and best known species is the *Tolypeutes tricinctus*, which has in front of the hindmost median head-plates two pairs of large plates. Another—



FIG. 21. — *Tolypeutes tricinctus*, three-banded armadillo.

Tolypeutes conurus — has in front of the hindmost plate an unpaired one, and in front of the latter a pair of plates. A third — *Tolypeutes muriei* — was comparatively lately (1878) discovered, and differs from the others by having three plates in a row in front of two hinder zygous ones.

A peculiar family, the CHLAMYPHORIDÆ, is represented by little animals found in the Argentine Republic east of Chili and in Bolivia. The fore feet are essentially like those of Dasypodidæ, and especially the Xenurines. The head is broad, and the ears, which are very small, are far apart; the cephalic buckler is continuous with the dorsal, and the latter is not differentiated into scapular, zoniferous, and pelvic regions, but the entire upper surface from the snout backwards is covered with a mantle of numerous similar zones widening to near the end; the hind quarters appear to be abruptly cut off,

and are protected by a special armature or pelvic shield of rows of plates concentrically arranged around the tail, and which is partly connected with the pelvis itself; the tail is small and curves under. According to Mr. E. W. White, the *Chlamyphorus truncatus*, "when walking, plants both the fore and hind feet on the soles," and carries "the inflexible tail, which it has no power to raise, trailing along the ground, and much inclined downwards from the body. As it commences to excavate, the fore feet are first employed; and immediately afterwards, supporting its body on the tripod formed of these and of the extremity of the tail, both hind feet are set to work simultaneously, discharging the sand with incredible swiftness."



FIG. 22.—*Chlamyphorus truncatus*, pichiciago.

Two species of the family are known, the Pichiciago, or *Chlamyphorus truncatus*, and the *Chlamyphorus retusus* of Bolivia.

The *Chlamyphorus truncatus* has only been found in a range extending "in latitude from the valley of Sonda, province of San Juan, 31° S. lat., down to San Rafael, seventy leagues S. of Mendoza, 34° S. lat., and in longitude from San Luis to the Andes." It has been the subject of several elaborate investigations. It is a small animal, and only about half a foot long when full-grown. The dorsal mantle is only attached about the middle line of the back, and the sides under the shield, as well as the abdomen and limbs, are clothed with silky hair. It is almost as much of a subterranean animal as the moles. It was first made known to science in 1825 by Dr. Richard Harlan, of Philadelphia, under the name it still bears.

The *Chlamyphorus retusus* is an inhabitant of Bolivia, and attains a larger size than

C. truncatus. The dorsal mantle is attached by its entire inferior surface to the back, and the lower parts are covered with woolly hair. Almost nothing is known of its habits, and it was only made known in 1865.

It is proper to add that there is a difference of opinion respecting the degree of value to be attached to the several groups here designated as families. Most naturalists unite all in one family; but the differences between the several types are analogous to those which are almost universally employed to differentiate families in the higher groups, and the degrees of divergence from each other or from a common stock can, apparently, be better appreciated and conveyed by their recognition as distinct families. The question may however be considered still an open one, and with almost equal propriety we can admit the families Tatusiidae, Dasypodidae, and Chlamyphoridae, or consider those groups as sections of a comprehensive family also called Dasypodidae.

SUB-ORDER II. — THE TARDIGRADA.

The designation Tardigrada expresses one of the chief physiological characteristics — slowness of progression — of the sloths, and this tardiness of movement is the result

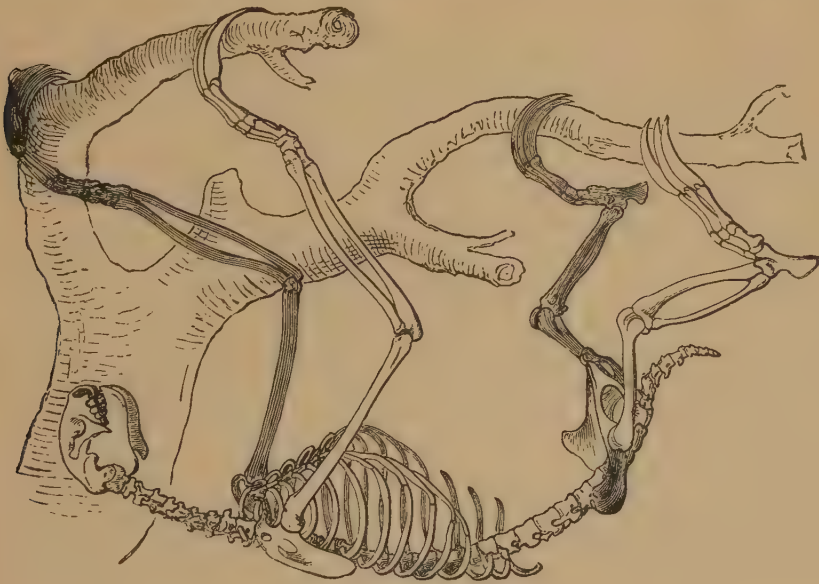


FIG. 22. — Skeleton of *Arctopithecus an.*

of curious modifications of structure. An abundant coat of hair is developed, while no dermal armature is present. Teeth are present in both jaws. The tongue is short and broad. The legs are almost as free as those of the apes, and the proximal segments entirely exerted except at their origins. The placenta is deciduate, dome-like, and formed from an aggregation of many discoidal lobes.

The living representatives constitute only one natural family; but a number of extinct edentates of larger and even colossal size were related to them, but differentiated so much as to be isolated in another family.

The existing Tardigrades, forming the family BRADYPODIDÆ, have lengthened as well as exerted limbs, the fore ones especially being very long; the toes are more or less reduced in number, and armed with long prehensile claws; the head is short and rounded, and the ears are rudimentary; there are teeth in each jaw—five above and four below on each side, and the tail is aborted.

The natural color of the hair is in most species a shade of gray, but there is almost always in some species a decided greenish tinge in the living animal in its native haunts, which might well mislead an ordinary observer—for the greenish hue is not due to the natural color of the pelage, but the growth of an algaous plant which belongs to the genus *Chlorococcus*. The structure of the hair in the sloths—roughened in *Bradypus* and fluted in *Choloepus*—is well adapted to harbor the alga, and the growth of the plant is further favored by the dampness of the forests in which the animals find lodgment. The growth of the plant doubtless is of service to the quadruped by assimilating it more to the color of the vegetation in the midst of which it lurks, and thus tending to conceal him from his enemies. But in any case the sloth has “a peculiar talent for making himself invisible. Even a medium-sized tree, without an excessive complement of tangle-vines has to be inspected thoroughly, and from different points of view, before a slight movement in the upper branches attracts your attention to a fluffy-looking clump not easy to distinguish from the dark-colored clusters of the feathery mistletoe (*Viscum rubrum*),” which occurs in the tree-tops of Southern Mexico, for instance. “Closely resembling clusters of feathery leaves and feathery hair are often seen side by side on the same branch—which of them is the animated one?” Missiles, thrown at the objects themselves are of little avail, “but with a good rifle you may dislodge the most tenacious tardo by hitting his branch somewhere below his foothold,” if he be, as will be most likely in Mexico, on a caucho-tree, “for a fractured caucho-stick will snap like a cabbage stalk. Thus displanted, the falling sloth clutches at the empty air or snaps off twig after twig in his headlong descent, but generally manages to fetch up on one of the stout lower branches, and at once hugs it with all the energy of his prehensile organs; and there he hangs, within easy reach of your arm, perhaps, but without betraying the slightest concern at your approach.”

The sloths are in the highest degree arboreal, and pass their entire lives among the leaves on which they feed. A hill-farmer of the Sierra Madre, in the Mexican State of Tabasco, assured Mr. Oswald that “a family of black tardos inhabited a clump of shade-trees behind his house for eleven years without ever descending to *terra firma* or even to the lower regions of their leafy domicile, and often passed weeks and months on the same branch.” Whether this statement be correct or not, they at least rarely descend to the ground. Sloths are peculiar, furthermore, in that they do not rest on the boughs, but for the greater part hang to the branches, back downwards, their long claws and co-ordinate characters enabling them to do so without fatigue or danger. They well deserve the epithet of sloth; for they are not only slow to move, but slow to think, slow to feel, and slow to die. They are brutal as contradistinguished from intelligent to an extreme degree. They cling to their apathetic life as much as reptiles, and withstand the effects of injuries and poisons to an extraordinary limit, and even after death irritability of the muscles long continues. As to other habitudes, they are most active or rather least inactive during the hours of darkness, and they generally live apart from each other or rarely in family groups. When from any cause, voluntary or involuntary, a sloth comes to the ground he is intensely awkward and almost helpless. The long limbs and the feet, turned inwards, and so well adapted for grasp-

ing, are used with difficulty and very slowly in terrestrial progression. The animal then moves forward on his elbows, and with the hind feet turned inwards, their edges and the sides of their claws resting on the ground. Thus, club-footed behind and crawling on the forearms forwards, the sloth's aspect is ungainly and unpleasant to contemplate; but provided the surface be rough, the poor being is able to advance at a moderate pace, and pulls himself forward by availing himself of projections and unevenness of the surface. If put on a smooth surface, however, he is almost incapable of progress; but transferred to a tree, provided the bark be rough, he is at once at home. He will ascend among the branches with comparative rapidity, and soon assume his natural position — under a branch with back downwards. "He moves suspended from a branch, he rests suspended from it, and he sleeps suspended from it." As has been already mentioned, the sloths are truly leaf-eaters, but they exercise a choice in their diet when they can. The terminal buds, the young shoots, and the unexpanded and new leaves are the favorite food, while the old leaves are rejected, except, perhaps, in dire necessity. And not all trees, even, are acceptable. Some species at least are very exclusive in their preference; a three-toed sloth, kept in confinement, would eat no leaves except those of the *Cecropia*. The two-toed sloth of Southern Mexico "contents himself with a diet which few of his fellow-creatures are likely to grudge him — the leathery leaves of the caucho (*Nyssa euphorbia*) and taxus tree. He sticks to the milky sap of his caucho-leaves, and totally abstains from water and all other seductive drinks."

Although very badly adapted for combat, they are, nevertheless, not entirely helpless; but some at least, if caught and attacked on the ground, throw themselves on their backs and attempt to wind their arms around their opponents, and thus strangle them. But such attempts at self-defence can readily be evaded by an agile foe, and a small weasel, for example, risks little or no danger in an attack on one many fold larger than itself. But if such agility is not exercised the incautious assailant may rue the attack. A dog, for instance, has been seized by the long claws, and torn or strangled to death. Nevertheless, such cases are exceptional, and apparently have only been exemplified by the large species. The Mexican sloth, according to Mr. Oswald, surrenders at discretion to all his enemies, great or small. "He permits you to lift his claw, but drops it as soon as you withdraw your hand. If you prod him he breaks forth in a moan that seems to express a lament over the painfulness of earthly affairs in general rather than resentment of your particular act." Again, "if a dog bites him, or if you offer him a tidbit after a prolonged fast, and snatch it away from his very jaws, he will slowly turn his head, and then, as if the significance of the indignity were gradually dawning upon his mind, he breaks forth into crescendo grunts, resembling at once the whirr of a buzz-saw and the droning hum of a bee-hive. I do not know if a sloth can be teased, for after trying all my conscience and Mr. Bergh would permit, that point still remains undecided."

In addition to the utterances given forth under the conditions just cited, the ear of the traveller in the forests in which the sloth dwells "is often startled by a singular cry in the tree-tops, a long drawn, tremulous moan, not unlike the wail of the whip-poor-will or a certain lugubrious variation of a watch-dog's yelp." A sloth has been giving voice to his feelings or lack of feelings.

There are some peculiarities of structure which are apparently in relation to the habits of these animals, and one is analogous to that manifested in forms that are very unlike them in most respects, but resemble them somewhat in habits. Two points that

have reference, one to the vascular and another to the intestinal canals, are of sufficient interest to detail.

The principal arteries of all the limbs are surrounded by plexuses of small vessels, or what are known as *retia mirabilia*, and it is interesting to observe that similar retia are developed, not only in all the other American edentates, but in the Lemurids of distant Africa. In the latter case, the similarity is noteworthy on account of analogous habits, for most of the Lemurids are also slow nocturnal animals, and the modification in question has been *supposed* to be correlated with the strain on the members in grasping and pulling the body forwards.

The intestinal canal, in the words of Flower, is "narrow and simple, and without cæcum, ileo-cæcal valve, or any great distinction between large and small intestine — offering a remarkable contrast in this respect to other animals having apparently precisely similar habits and food, as the *Indris* among the lemurs, and koala among the marsupials, in which the stomach is small and simple, and the intestinal canal, especially the colon and cæcum, of enormous length and capacity."

As to the reproduction of the sloths, it must suffice that they generally produce only one at a birth. A mother in captivity carried her young, when born, in her "lap," and not on the back, as some have supposed to be the natural manner. The young is nourished at the breast, as in those arboreal mammals generally which move among the branches by the use of their arms.

The sloths are limited to the densely-wooded regions of equatorial America, and extend northwards into Southern Mexico. The number of species is uncertain, but is probably less than the twelve which have been claimed by some naturalists to exist.

But, on the other hand, differences within the family are greater than might be at first supposed. Contrasting as they do with other mammals, the range in variation in the family might be lost sight of. A careful study of the species, however, reveals the existence of differences which have been even used to divide them into two families, and which, at any rate, warrant the naturalists in distinguishing two sub-families; these are the three-toed sloths, or Bradypodines, and the two-toed sloths, or Cholopodines.

The three-toed sloths (Bradypodinæ), as the name implies, have three toes to the fore feet, as well as the hind ones, these three being the second to fourth of the typical number, the first and fifth being aborted; the skull is short, and the lower jaw truncated in front; the foremost teeth are like the others; there are nine cervical vertebræ, and twenty abdominal, of which fifteen to seventeen bear ribs.

This number of cervical vertebræ is exceptional among mammals, almost all others having seven, the long-necked giraffe and the neckless whale not even excepted. The increased number of vertebræ adds greatly to the flexibility of the neck, and the head can be turned round to an extraordinary degree.

The largest and also the most numerous of the sloths belong to the three-toed group. As many as ten species have been distinguished, but probably this number will require reduction when the range and characters of the several forms become better known. But these species, whatever may be their real value, represent two closely-related genera — *Bradypus* and *Arctopithecus*.

The collared sloth (*Bradypus triadactylus*, or *torquatus*) is the largest of the family, and one of the two longest known, although its early history was involved with that of other species. Male and female are alike in color. The neck is collared with a zone of long, black hair, widest, but distichous, on the back; the crown is yellowish, the

forehead, throat, and breast reddish or grizzled, the face blackish (and naked), and the rest of the body pale orange.

The Ai (*Arctopithecus ai*, or *flaccidus*) has a more or less distinct spot or streak on the forepart of the back, and elsewhere is gray-brown. The specific name is derived from the interpretation of some native Brazilians of the cry which it occasionally sends forth.



FIG. 24. — *Bradypus tridactylus*, three-toed sloth ; collared sloth.

The two-toed sloths (*Choloepodinae*) have, like three-toed ones, three toes to the hind feet, but only two to the fore ones — these representing the second and third of the pentadactyle manus; the skull is less shortened than in three-toed sloths and the lower jaw is somewhat produced forwards; the foremost teeth of each jaw are enlarged and canine in form, but, in comparison with normal mammals, reversed in interlocking, the lower teeth sliding behind the upper instead of in front of them; there are either six or seven cervical vertebræ and about twenty-seven abdominal, of which about twenty-three or twenty-four have ribs.

The number of cervical vertebræ, it will be thus seen, may be at one extreme, as exhibited in the mammals, and thus contrasts with the other extreme developed in the three-toed sloths. The little importance to be attached to the exact number in this group is, however, evident from the fact that two species which are undoubtedly closely related differ in this respect, one having six and the other the typical mammalian number — seven.

There are two quite distinct species of *Cholopodines*, one ranging over South America and the other confined to Central America.

The Unau, or common Two-toed Sloth of Brazil, *Cholopus didactylus*, was known to Linnæus, who gave it its specific name. Its head is longer and its fore legs shorter than are those parts in the three-toed sloths, but these features are not carried to such an extent as in the next species. It has the normal number (seven) of cervical vertebræ, an additional character separating it from the Central American form. The stomach is complicated, consisting of a large, anterior, three-pouched portion, and a much smaller posterior part, the whole suggesting the more extensively divided organ of the ruminants.

The Unau is darker than other sloths, but there is considerable variation in shade in different individuals, and in all the claws are pale, sometimes nearly white.

Mr. Burchell kept several individuals in captivity, but the full-grown individuals were never known to utter a sound, but the young on rare occasions make a shrill, whistling squeak. They "showed no indication of fear, and seemed to give attention only with their eyes. They took no notice of the boy, who often carried them across the garden to their place on the verandah, with their long arms sprawling; the only objects of their regard were trees. They fight on their backs, and grapple their enemy to strangulation. The use of the long wool that covers the body, and even the face, seems to be to guard them from the annoyance of insects. Possibly it may preserve them from the attacks of snakes, which are, doubtless, their greatest enemies."

The Central American Two-toed Sloth, *Cholopus hoffmanni*, was first distinguished in 1858. It has only six vertebræ in the neck, and its arms and claws are shorter than those of the unau. The hair is long, pale brown in color, and lighter at the tip. The face is nearly white, with a brown band across the nose, and a similarly colored ring around each eye. The snout is hairless, and of a light reddish tint.

Since this species was first indicated by Dr. Peters, several specimens have been studied in confinement; but the habits of this, as well as the preceding species, possess but little interest beyond those given in the general account of the family.

It may be stated, in conclusion, that the distinction between the three-toed and two-toed sloths is still further confirmed by other characters than those mentioned; for instance, the development of the periotic bones, the scapula, the carpus, and tarsus, and their relation with the metapodials, the complexity of the stomach and liver, and the presence or absence of a gall-bladder and seminal vesicles.



Cholopus didactylus, two-toed sloth, unau.

SUB-ORDER III.—THE VERMILINGUA.

This sub-order of edentates, comprising the true ant-eaters, is most nearly related to the sloths, although its representatives are quite different in appearance. Like the last, however, the ant-eaters have an abundant coat of hair—and hair only. Teeth are entirely absent. A long exsertile tongue serves to procure its favorite food. The proximal joints of the legs are more or less contained in the common integument. The placenta appears to be deciduate and is sub-discoidal or dome-like.

The Vermilingua are at the same time representatives of a sub-order and family, and in their latter character have the name MYRMECOPHAGIDÆ.

The ant-eaters have stout and moderate limbs, with tetradactyle or pentadactyle hind feet and much modified fore feet, whose third toe is especially enlarged and armed with a long, curved claw; the head ends in an elongated snout, and the mouth is tubular, with a small anterior opening; the ears are small but distinct; and the tail is more or less elongated.

As is indicated by the names, the ant-eaters are insectivorous, and the largest species live almost exclusively on ants, but not all the species of the family are confined to the formicid insects. In this respect the several forms differ. All, however, are especially adapted for the capture of insects. This is effected by means of the long vermiform tongue and the viscid secretion which that organ receives from the very large sub-maxillary glands. The tongue is protruded by the animals on or in the path of its prey, and when the latter has been taken, is withdrawn, and transfers the freight into the pharynx. The further consideration of habits may be best specialized under the several groups. There are three forms which are at once recognizable, and which a little study renders evident can be classified under two groups; and these groups, it may be premised, appear to be of sub-family rank and will be so called here.

The Myrmecophagines have five digits to each fore foot, but the outer is much reduced and the third is by far the largest, and armed with a very long claw; the rostral portion of the skull is very long and narrow; the palate is produced far backwards by the meeting of the enlarged pterygoid bones of the respective sides; the mouth is very small. Three species are known—the great ant-eater, or ant-bear (*Myrmecophaga jubata*), the collared Tamandu (*Tamandua bivitata*), and the yellow Tamandu (*Tamandua longicaudata*).

The Cycloturine sub-family is distinguished by the reduction of the fore paw, the first as well as fourth and fifth fingers being very rudimentary and invisible externally; the rostral portion of the skull is comparatively short, and the canal for the posterior nares is not closed below, the palatines and pterygoids of the two sides not meeting as they do in the Myrmecophagines; the mouth is comparatively large. Two species have been described—the little ant-eater of Brazil (*Cycloturus didactylus*), and one discovered in Costa Rica (*Cycloturus dorsalis*).

The little ant-eater is almost as completely restricted to life on the trees as are the sloths, and the entire structure is modified in accordance; the hind feet are especially noteworthy, and have been emphatically designated as climbing organs. According to Flower, "the hallux is rudimentary, consisting of a metatarsal bone and one phalanx, concealed beneath the skin; but the four other toes are sub-equal and much curved, with long, pointed, compressed claws. The *tuber calcanei* is directed towards the

plantar surface and parallel with it, and extending to about double its length, is a greatly elongated sesamoid ossicle articulated to the internal cuneiform bone. These together support a prominent calcarine cushion, to which the claws are opposed in climbing."

We have now completed the consideration of the American edentates. As will be seen hereafter, these agree not only in geographical distribution, but also in structural characteristics, when contrasted with the edentates of Africa and Asia. The latter



FIG. 25. — *Myrmecophaga jubata*, ant-eater, tamandu.

now demand our attention. They are much less numerous in species and still less diversified in structure than their American relatives, for there are only two homogeneous families, and the representatives are severally so much alike that those of each family have been considered by most naturalists to be strictly congeneric. Nevertheless, the differences between the two families are so great as to differentiate them likewise as subordinal types.

SUB-ORDER IV.—FODIENTIA.

The Fodients are only two, or perhaps three, species in number; but the characters which they present so isolate them that they must be distinguished not only as a very distinct family, but also as a sub-order. They are unprotected by a dermal arma-

ture of any kind; teeth are developed of a peculiar character; each one "is made up of an aggregation of parallel dental systems, having a slender pulp-cavity in the centre, from which the dental tubes radiate outwards; and, being closely packed together, each system assumes a polygonal outline, as seen in transverse section. No evidence of any vertical succession of teeth has been discovered." The limbs have their proximal segments enclosed in the common integument. The placenta is broadly zonular.



FIG. 27. — *Orycteropus capensis*, aard-vark.

As a family the Fodients are entitled ORYCTEROPODIDÆ. The name Aard-vark is simply the Dutch equivalent of ground-hog, and is the appellation given by the original colonists of the Cape Colony to the species of South Africa. The form but slightly resembles that of the hog. The feet, compared with those of the types already described, are normal and applied to the ground essentially like those of other mammals; the hind feet are plantigrade and provided each with five toes; the fore feet are four-toed, the pollux or thumb being wanting, but all the others are well developed; the second and third sub-equal, and the fourth and fifth shortened. The head is elongated conic, the snout somewhat suilline, and the mouth sub-tubular; the teeth number eight to ten in the upper and eight in the lower jaw,

although not all present at the same time; the ears are large and distant from each other, and the tail is stout and elongated conic.

The *Orycteropodids* are confined to Africa, and excavate and live in burrows. They chiefly feed on insects, and especially ants, which are secured by a very extensile tongue, which is, however, much shorter than in the true ant-eaters. Secreting themselves in burrows and rarely coming out in the daytime, they are rarely to be seen in their native haunts, even though they be quite common. If by chance found out and chased they can dig into the soil so rapidly as to be out of sight when the pursuer has approached, and they can work in the ground as fast as the huntsman can. But their strength is rarely used against their enemies, and if caught they are wont to resign themselves to fate with but little attempt at resistance or retaliation. Their flesh is said to be quite savory, and the "hams" of an animal in good condition (and it is rare to find one otherwise) are regarded as a great delicacy. Their diet of ants, instead of injuring them for the table, is claimed to impart, in the state of formic acid, an agreeable and peculiar taste to the meat. Two species are well known, and have been long exhibited in zoological gardens.

The Aard-vark of the Cape (*Orycteropus capensis*) has been longest and best known. Its hairy investiture is sparse, and contributes to the animal's resemblance to a hog—which it also approaches in size. It is distributed over a wide range in South Africa.

An analogous species (*Orycteropus aethiopicus*) is an inhabitant of Southern Nubia and neighboring countries. It is better clothed with hair than the Cape species, and is otherwise distinguished from that animal, but resembles it in general appearance and size.

In captivity the *Orycteropodids* conceal themselves in the straw strewed in their cages, and sleep during the hours of light, but are comparatively lively at night, and when food is introduced into their quarters they slowly bestir themselves, first protruding their long snout and ears, and finally come out to indulge in the repast afforded them.

SUB-ORDER V. — SQUAMATA.

The Squamates are edentates as remarkable for their covering as the loricates, but this covering is of a very different character. Large, horny scales, resembling superficially the scales of some kinds of pine-cones, extend over most of the body and remind the observer rather of reptiles than mammals, but the belly and intervening spaces develop hair like that of other mammals. Teeth are entirely wanting. The placenta is diffuse and non-deciduate, as in many ungulates.

The Pangolins, which form the family *MANIDÆ*, like others of the edentates, are peculiar in their mode of progression. The hind feet are but little modified, and are plantigrade and five-toed, but the fore feet are characteristic; five digits are developed, all of which are broad, excepts the innermost, and of all the terminal joints are deeply cleft; the third digit is much the longest, and next is the fourth, while the first, second, and fifth are successively (the last sometimes very much) reduced. But the chief peculiarity is in that the animal advances on its knuckles and with the claws bent inwards or upwards. The head is coniform and the snout sub-cylindrical; the ears are small and far apart; the tail is elongated, very broad and continuous, without constriction from the trunk.

The elongated form and gradual tapering into the tail, combined with the longitudinal rows of leaf-like scales, short legs, and knuckle-walking, give the pangolins an unique appearance, and they may be at once singled out from all other animals. The species are peculiar to tropical Asia and Africa, and are insectivorous, feeding mainly on ants and termites. For this purpose their tongue is especially adapted, that organ being very large and vermiform, but flattened towards the extremity, and very extensile. When the forager has found an ant's nest he inserts his tongue, covered with a glutinous secretion which holds fast the insects, into the hole, which already exists or which he makes, and then withdraws it covered with living freight into the mouth. The front claws, as already indicated, are very strong and render the animal an efficient digger. They burrow rapidly in even quite hard ground, and generally remain in their holes in the daytime. Their feeding-time is as a rule the night. If one is approached by an enemy, he rolls himself up in a ball-like mass, with the snout between the legs, and with the scales bristling outwards in every direction. The stomach is almost always the receptacle of small stones, which, it is supposed, have been swallowed to aid in the trituration of the food. It may be added that the stomach itself has thickened muscular walls and lining membrane, and "a special gland near the middle of the great curvature, consisting of a mass of complex secreting follicles, the ducts of which terminate in a common orifice."

The popular name — pangolin — which has grown into use as a *quasi* generic designation of the species, is a Malayan word (Pångaling, Pånggheling, or Pengolin), used specifically for the *Manis* (*Pholidotus*) *javanus*, and is descriptive of its ability to roll itself up into a ball. The technical name given by Linnæus is the supposititious singular of the Latin word for spirits or ghosts, — *Manes*, — and was imagined on account of the weird and unearthly appearance of the animal, or rather, perhaps, because of its nocturnal habits and its slow wandering during the night. The Manids are also frequently called scaly ant-eaters; the reason therefor is obvious, but the term is somewhat objectionable, because it implies, or may at least be supposed to imply, a closeness of relation to the ant-eaters of South America, which does not exist.

Seven or eight or even more species of Manids have been recognized by naturalists; and these are so closely related as to have been united by most writers in a single genus, although by one zoologist (the late Dr. Gray of the British Museum), they have been distributed among no less than five genera and three tribes. Such a sub-division, however, is entirely negatived by the comparative structural details of the respective species, but it will be convenient to consider them under three categories.

The typical Manids, that is, those for which the generic name *Manis* has been universally retained, have a very long, slender tail, narrow scales, and the feet hairy. Two species have been found in Africa, the *Manis longicauda*, or long-tailed pangolin, and *Manis tricuspis*, or the Phatagin. The former has eleven longitudinal rows of scales of a dark-brown color, while the latter has as many as twenty-one rows, and the color of the scales is pale-brown. Both are inhabitants of Western Africa, Guinea, etc.

Other species have also a long tail, although shorter than the first, but the scales are broad, and the feet are covered above with scales which extend to the toes. The name *Pholidotus* has been appropriated to them, and at least four species are known, three of which occur in the Indian region and one in Africa. The African species, *Pholidotus giganteus*, is the largest of its family, having a total length of nearly five feet, of which the tail forms less than half. The Oriental species are the *P. indicus*, which has a

wide range through India, the *P. javanus*, of Java and Sumatra, and the *P. dalmann*, of Northern India, China, and Formosa.

The *Pholidotus javanus* inhabits "hollow trees, feeds on ants [including termites] alone, of which its stomach contains thousands. It is a slow-moving animal, but very strong, and by means of its powerful prehensile tail (which is furnished with a little naked callosity) climbs tolerably well among rocks and dead trees. The tongue is exceedingly long, round, and fleshy, and is used to obtain its food by being laid across the tracks of ants, which stick to a glutinous secretion with which it is provided."



FIG. 27. — *Manis longicauda*, long-tailed pangolin.

Two individuals of the Manid of Ceylon (the *Pholidotus javanus*?), called in that island Caballaya, were at different times kept in confinement by Sir Emerson Tennant while resident there. One was about two feet long, and obtained from the vicinity of Kandy; it was "a gentle and affectionate creature, which after wandering over the house in search of ants, would attract attention to its wants by climbing up" its master's knees, laying hold of his leg by its prehensile tail. The other, more than double that length, was caught in the Jungle near Chilau, and brought to Sir Emerson Tennant in Colombo. "I had," says that gentleman, "always understood that the pengolin was unable to climb trees, but the one last mentioned frequently ascended a tree in my

garden in search of ants, and this it effected by means of its hooked feet, aided by an oblique grasp of the tail. The ants it seized by extending its round and glutinous tongue along their tracks. Generally speaking, they were quiet during the day, and grew restless as evening and night approached."

A Manid inhabiting Eastern Africa is distinguished from all those hitherto referred to by its proportions and other characters. The tail is very broad, compared with other forms, and is rounded at its end; the scales are broad and short, and the central ones do not continue on the tail; the feet above are covered with scales down to the toes. But one species of this section is known, and has been named *Smutsia temmincki*, and occurs in Sennaar, Caffraria, Kordofan, Latakoo, and adjoining countries. It attains a length of about three feet.

There still remain certain forms to be noticed which are no longer living, but which it is necessary to consider if we would understand the relations of the several types to each other. Some of these forms are as well known, so far as the osteology is concerned, as any recent ones, but others have been very imperfectly indicated, being known only through fragmentary remains.

In the American hemisphere several extinct families have been recognized.

In the miocene and pliocene ages, in North America, some edentates existed which have been noticed by Prof. Marsh under the family name, MOROPODIDÆ. Little, almost nothing in fact, is known of them, for only fragments have been found.

But in later formations abundant remains have been gathered, which have enabled zoologists to reconstruct the skeletons of various species representing two peculiar families.

The MEGATHERIIDÆ were animals related to the sloths, and also, but to a much less degree, to the ant-eaters, and represented a more generalized type than either. They had teeth similar to those of the sloths as to constitution and number, but they were of a prismatic or quadrate form; their tail was very large, their pelvis unusually wide, the legs were but moderately long, and the feet peculiar. They varied in size, but were much larger than the existing sloths, and some attained elephantine dimensions. They were consequently not arboreal animals, but moved over the earth, although they must have presented an awkward appearance in so doing, for their fore feet were turned inwards, and their weight was borne by the outer toe, which is supposed to have had a callous pad, while the claws were chiefly bent upon the under surface or palms.

The life history of the Megatheriids is but imperfectly known. Remains have only been found in the post-tertiary deposits of the American continents, but these were then quite numerous in species and genera, and the largest species ranged over a large portion of South as well as North America, and have been distinguished as *Megatherium americanum*, and *M. mirabile*.

The GLYPTODONTIDÆ were mammals most nearly related to the existing armadillos, but which attained a much larger and even gigantic size; they had also a more complete turtle-like carapace, that covering, instead of being divided into transverse bands, being a single undivided "shell," composed of very numerous polygonal scutes; furthermore they possessed a ventral shield or plastron simulating that of a tortoise. Their tail was club-like, moderately long, very stout, and incased with rings of united and often knobbed scutella. The teeth were thirty-two in number, eight on each side in each jaw, and were severally contracted by two re-entering internal as well as external grooves, so that their crowns presented three peninsular areas. (This peculiarity gained

the name—*glyptos*, fluted, and *odous*, tooth—of the typical genus from Owen.) All these peculiarities were reinforced by others, and hence the Glyptodonts were isolated from all known types as a very distinct family. But with all their common characters they manifested a wide range of variation, and about two-score of species have already been discovered, for which five genera are recognized by the most conservative naturalists. The legs of all were short and robust and the feet elephantine, but they differed considerably in the development of the digits of the fore feet; some (the Glyptodontines) were deficient in the fifth toe, and others (the Hoplophorines) in the first.

The Glyptodonts existed in South America in the pleistocene age, and their bones have been chiefly found in the fluviatile beds of the Argentine Republic with those of Megatheriids.

In the Old World remains of edentates have likewise been found, and in regions whence they have long since disappeared. Such remains have been chiefly obtained in France and Greece in deposits of miocene or middle tertiary age, but Gervais long ago indicated the existence of a supposed representative of the order in the eocene period. The remains hitherto obtained have been almost solely limb bones, but teeth have been also claimed for the fossils. The phalangeal bones most resembled those of the Manids, and it is supposed the extinct forms belonged to a generalized type near the line of descent for the existing pangolins. The names *Macrotherium*, *Limognitherium* and *Ancylotherium* have been proposed for the fossils, and the family names, MACROTHERIIDÆ and ANCYLOTHERIIDÆ, have also been suggested. More information respecting these forms is needed.

The correlation of the data derived from the consideration of the living as well as extinct edentates yields definite information as to the mutual relations of the several sub-orders, and a study of the osteology affords an excellent clew.

An examination of the skeletons of the American edentates reveals a notable peculiarity of the hinder thoracic and the lumbar vertebræ. In addition to the articular processes, or *zygapophyses*, which connect the several vertebræ with the preceding and succeeding, as in ordinary mammals, there are other projections to the præsacral vertebræ, which reciprocally fit into each other and interlock the contiguous vertebræ in a manner quite exceptional among vertebrates. These accessory articulations are well exemplified in the Dasypodids and Myrmecophagids, as well as in the extinct Glyptodontids and Megatheriids, and are also developed in the Bradypodids, although much more faintly than in the others. Their minor development in the sloths is doubtless the result of the mode of life, and is the co-ordinate of the slight strain on the back; disuse or slight use has resulted in comparative atrophy of all the processes of the vertebræ and the muscles which are attached to them.

A comparison of the skeletons of the African and Indian edentates becomes remarkable by the contrast with the corresponding vertebræ of the American forms. No accessory processes are developed by the thoracic and lumbar vertebræ, but only the ordinary zygapophyses are present. In this respect the Orycteropodids and Manids, although so different otherwise, agree with each other.

The features of the geographical distribution of the edentates are then coincident with structural characters. To America belong the *xenarthral*, or many-jointed forms, while to the eastern hemisphere are restricted the *nomarthral*, or normally articulated types. The two groups are evidently natural assemblages, and doubtless have been derived from different progenitors, and represent two different lines of descent. The earliest edentates, or rather their ancestors, there is good reason to believe, were quite

normal, but inferior and generalized placental mammals provided with teeth and with normal vertebræ, and the characters that now isolate some of them are secondary and have supervened at various later stages of their development.

Different as the American edentates of the existing fauna are from each other, they are connected with extinct types and thereby with each other to a notable extent. The Glyptodontids and the Megatheriids are evidently much more alike than are their respective living representatives, the armadillos and the sloths. Again, the Megatheriids are to a quite appreciable extent intermediate between the sloths and the ant-eaters; and we are apparently justified in the supposition that those two families have descended from forms quite like the Megatheriids, although doubtless earlier in time, still more generalized, and without the strict "family" characters of those animals.

The Old World types of edentates are more isolated than the American, and paleontology has not as yet much lessened the gap between them. We only know fragments of the skeletons of extinct European edentates which have been referred to the families Macrotheriidae and Ancylotheriidae, but those fragments are sufficient to at least indicate that the animals of whose skeletons they formed a part were less specialized than the living Orycteropodidae and Manidae.

But although much remains to be learned respecting the history of the order, we seem to be justified by the known facts in inferring that from some early primitive stock the edentate order became developed, and early split into two branches, one of which became specialized in the eastern, and the other in the western hemisphere, and the territories thus occupied remained free from the invasion of each other. The details of this history can only be vaguely surmised at best, and may long and perhaps ever remain unknown.

THEODORE GILL.

ORDER II.—RODENTIA.

The Rodent or Gnawing quadrupeds constitute by far the most extensive order of mammals, as well as one the members of which are greatly diversified in form and function. Nearly all of them are small creatures, some being the most diminutive of mammals, excepting the shrews. A rat or squirrel is not above the average size; a rabbit is a large rodent; the beaver a giant; the capybara a Titan. Their vital activities are exhibited in various guises; they enjoy every method of locomotion possible to animals without wings, and live not only on the face of the earth, but in its interior, in the water, in trees,—some almost in the air, like birds. All are herbivorous, and probably no edible vegetable substance comes amiss to one or another; while some, like the rat, are almost omnivorous. Though a “feeble folk,” comparatively insignificant in size and strength, they hold their own in legions against a host of natural enemies—rapacious beasts and birds—by their fecundity, their wariness and cunning, their timidity and agility, their secretiveness—each after the means with which it is provided for exercising its instinct of self-preservation, among which insignificance itself is no small factor. In regard to man, some rodents are his parasites; some are among the most serious obstacles with which he has to contend in his natural avocation of tilling the soil; others furnish him with food and clothing; but none become his servants. Rodents cover all four quarters of the globe at the present day, and in geological time extend through the “age of mammals.” What is the key to the place in nature of such creatures as these? What’s in a name—Rodentia?

Any living animal is determined to be or not to be a rodent by the teeth; and, with a single exception, the same method of determining holds good for all the forms which have passed away since the sun rose upon an eocene horizon.

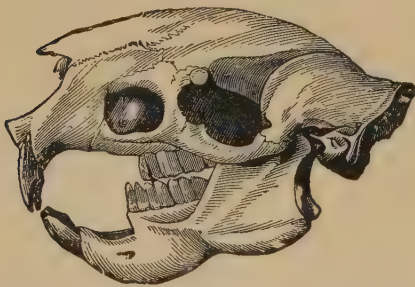


FIG. 28.—Skull of a Porcupine, *Hystrix cristata*, to show rodent dentition.

There is a great toothless gap in each jaw between the incisors and the molars, no canines being developed in any rodent. Moreover, the upper incisors, viewed from the front, are never more than two in number—excepting in the case of a young animal of the hare tribe, which may show six, or an adult of the same group, which, after shedding one pair of useless front teeth, retains a small supplementary pair, placed directly behind, not on each side of, the middle pair. No living rodent has more than one pair of lower incisors; and only in

that most exceptional case of the extinct genus *Mesotherium*, is there an additional pair. This state of the case is expressed numerically by the formula, $i. \frac{2}{2}$; that is, a pair of incisors in each jaw, only variable to $\frac{4}{2}$ or $\frac{6}{2}$ in the hare tribe, and to $\frac{2}{2}$ in the curious old fossil just named.

But these teeth have a more important bearing than that of mere number. They have no limit of growth. They are long curved tubes of enamelled dentine, open at the roots, and, in fact, are hollow and filled with pulp in most of their extent, only solidifying and hardening in the portion which cuts the gum. The inserted portion is

very extensive, traversing much of the upper jawbone, and more, sometimes the whole length of the under jawbone. The line of growth is always in the arc of a circle — above, a large arc of a small circle; below, a smaller arc of a larger circle; so that when they protrude their tips fall exactly together. There is a remarkable provision for sharpening these teeth to a bevelled edge, like that of a chisel, and for keeping them sharp; in fact, each serves as a whetstone to the other. For the front surface is very heavily enamelled (this mail being commonly orange or red), while the opposite side consists of the softer dentine, quite naked, or only coated with the thinnest possible enamel. Thus the teeth, by mutual attrition, keep a sharp bevelled edge of enamel, from the more ready wearing away of the dentine. Such teeth are called *scalpriform*, or scalpel-shaped; it would be more apt to say they are adze-like. That the enamel must also wear, only less easily, is evident from the fact that the whole tooth grows continually; and when from any accident, the opposing teeth do not meet exactly to perform their whetting office, — as when one is broken off, or grows out of line, — disastrous and fatal results ensue. For, meeting with no opposition, the tooth then becoming a great tusk, grows on in its arc till it may almost complete the circle, piercing the flesh or the skull itself, or otherwise interfering with the use of the mouth, till the unfortunate animal miserably perishes.

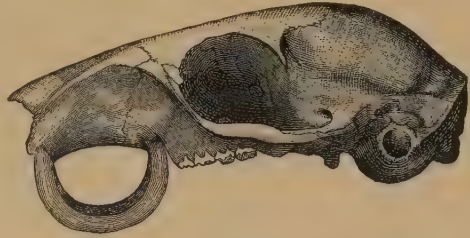


FIG. 29. — Side view of skull of a squirrel, showing the upper incisors grown into a circle, piercing the skull.

When rodent dentition is at its height, the back teeth have a similar perennial growth, only limited by the pulp-supply of these powerful molar instruments. In such cases they consist of a number of prisms, coated with enamel and cemented together, with open roots and persistent pulp-cavities. They are quite straight and perpendicular; and their crowns, worn flat by mutual attrition, present an intricate, and, in different species, an endlessly varied pattern of the enamel-folds and of the enclosed dentine areas, which are often quite insulated from one another. A muskrat, or lemming, or any other Arvicoline, shows this well. More frequently, moreover, the grinders are rooted, having a limited period of growth, like ordinary teeth. Their crowns in such instances are usually tubercular, and only after the tops of the tubercles are ground down do they show much intricacy of pattern. No rodent has more than three molars on each side, above and below. It is normal to rodents to have no premolars at all. Their back teeth are therefore typically expressed by the formula, $m. \frac{6}{6}$. Many, however, have a single premolar above and below on each side; in which case a formula is $m. \frac{6}{6}, pm. \frac{2}{2} = \frac{8}{8}$ for the back teeth collectively. In many cases, moreover, notably among the squirrels, there are two premolars above on each side, with one below, yielding $m. \frac{6}{6}, pm. \frac{4}{2} = \frac{10}{8}$; but such additional premolar is always very small, and often deciduous. In the hare tribe the grinders are increased by additional premolars, till they become $m. \frac{6}{6}, pm. \frac{4}{4}$ (pika), or even $pm. \frac{6}{4}$ (hare); thus yielding, with $i. \frac{2}{2}$, the maximum number of teeth (26 or 28) in the order. (Possibly the singular murine genus, *Heliothobius*, with $m. \frac{6}{6}, pm. \frac{6}{6}, i. \frac{2}{2}$, has also 28 teeth.) Decrease from the typical number of $m. \frac{6}{6}, pm. \frac{0}{0}$, is only known to occur in one murine genus, *Hydromys*, with $m. \frac{4}{4}, pm. \frac{0}{0}$, giving, with $i. \frac{2}{2}$, the minimum number of 12 teeth. It is the rule that there is an equal number of teeth in each jaw; the principal exceptions being furnished by

the hares with $\frac{1}{2}$, the pikas with $\frac{1}{4}$, and those squirrels which have *pm.* $\frac{4}{2}$, making $\frac{1}{2}$. With the same exceptions, the different kinds of teeth are the same in number in the two jaws. The total of the teeth is *typically* 16, as normally throughout the immense Murine series, though with several exceptions; but this is very frequently increased to 20, as almost unexceptionally in the Hystricine, and usually in the Sciurine, series.

The four formulæ, which respectively characterize as many principal groups of living *Rodentia*, are as follows:—

For the *Leporine* series:—*m.* $\frac{6}{6}$; *pm.* $\frac{4}{4}$ or $\frac{4}{4}$; *c.* $\frac{0}{0}$; *i.* $\frac{4}{2} = \frac{1}{2}$ or $\frac{1}{2} = 28$ or 26 (no other variation).

For the *Hystricine* series:—*m.* $\frac{6}{6}$; *pm.* $\frac{2}{2}$; *c.* $\frac{0}{0}$; *i.* $\frac{2}{2} = \frac{1}{0} = 20$ (only varies to *pm.* $\frac{0}{0}$ in one case).

For the *Murine* series:—*m.* $\frac{6}{6}$; *pm.* $\frac{0}{0}$, or $\frac{2}{2}$ or $\frac{2}{2}$; *c.* $\frac{0}{0}$; *i.* $\frac{2}{2} = \frac{8}{8}$, $\frac{1}{8}$, or $\frac{1}{0} = 16$, 18, or 20 (only varies otherwise to *m.* $\frac{4}{4}$ in one case (total 12), to *pm.* $\frac{0}{0}$ (total 28) in another case).

For the *Sciurine* series:—*m.* $\frac{6}{6}$; *pm.* $\frac{2}{2}$ or $\frac{4}{2}$; *c.* $\frac{0}{0}$; *i.* $\frac{2}{2} = \frac{1}{0}$ or $\frac{1}{0} = 20$ or 22 (no other variation).

It will be seen that the variability in any one formula (excepting the anomaly of *m.* $\frac{4}{4}$) is confined to the premolars; that these only vary in one instance in the Hystricines; and that the incisors only vary from $\frac{2}{2}$ to $\frac{4}{2}$ in the Leporines. The formula for a single anomalous fossil genus (*Mesotherium*, in which the incisors, moreover, are not adze-edged), completing an exhibit of rodent dentition, is:—*m.* $\frac{6}{6}$; *pm.* $\frac{4}{2}$; *c.* $\frac{0}{0}$; *i.* $\frac{4}{2} = \frac{1}{2} = 24$. The rodent dentition is certainly characteristic, and indeed diagnostic, of the order; yet the only absolutely unqualified expression to be used regarding its numerical composition is, there are no canines.

In the perennial incisors, which would be tusks were they not perpetually ground down, and in the often prismatic and changeable molars, the dentition of these small quadrupeds curiously resembles that of the huge elephant. Rodents are very precocious in their teething, and some, as the Guinea-pig, cut and shed their milk-teeth before they are born,—which would be a great convenience in some other cases, seeing how mothers and children both suffer sometimes in dental crises.

The form of the head of the under jawbone, which articulates with the skull, and that of its socket, are interesting in this connection, as they permit the incisors of either jaw to overlap those of the other, as is necessary in order that they may sharpen each other. For, in addition to such up-and-down, and such sidewise, movements as the jaw may execute, it also slides a little way back and forward. This is effected by the direction of the long diameter of the articular head of the bone, or condyle (which is parallel with the long axis of the skull, instead of transverse to that axis, as usual among quadrupeds), and by the shallowness of the glenoid cavity or socket which receives the condyle.

Whatever the size of the eyes, and they vary much, their sockets, the orbital cavities, always communicate openly with the temples, or temporal fossæ, the rim of the orbit being deficient behind.

Though rodents are far from being witless animals, they belong to a lower series of mammals called Ineducabilia, from the comparatively small size and simplicity of the brain, and consequent low grade of intelligence on the whole. The cerebrum, or great hemispheres of the brain proper, are small, uncovering much or all of the cerebellum or hind-brain; and the surface of the cerebrum is usually quite smooth, having at most a few simple convolutions in some exceptional cases. There is a transverse commissure

of the hemispheres, as in all placental mammals; and the placentation is of the kind known as discoidal deciduate. The intestinal canal is extensive and much convoluted; there is a large cæcum (except in one family); but the stomach appears simple, at any rate in comparison with its complexity of structure in most other herbivorous quadrupeds. The structure of the ear-parts indicates a high grade of auditory power; the sense of sight is also good, as a rule, though some of the burrowing rodents are literally as "blind as a mole," the eyes, in one species at least, being rudimentary and covered with the skin. The general configuration of the body, the proportions of the limbs, and other details, are endlessly varied; and, not to here pursue the subject into details, properly coming up further on, we may conclude by saying that a rabbit, a squirrel, a rat and a porcupine severally illustrate the four leading modifications of structure which rodents of the present epoch exhibit.

The very numerous rodents exhibit so much diversity in form that it becomes an interesting question, How may this large order be divided into lesser groups in a manner which shall indicate the true affinities and relationships of its several components? Many modes of classifying the Rodentia have been invented and applied to their arrangement in families and genera. The basis of a sound classification was laid down by Mr. Waterhouse in 1848, and subsequently elaborated with care and success by the late Mr. E. R. Alston, whose untimely death left unusual promise unfulfilled. His arrangement is accepted by most naturalists with little modification, and will be closely followed in the present article. In this scheme, the peculiarities of the single fossil, *Mesotherium*, and of the existing hares and pikas (*Leporidae* and *Lagomyidae*) are considered to furnish, when contrasted with each other and with all other Rodentia collectively, a means of dividing the order into three sub-orders. The incisor dentition alone gives the clue to these divisions, as follows:—

- I. Upper incisors 2, lower 4; enormal or blunt-toothed
 Rodents Sub-order HEBETIDENTATA.
- II. Upper incisors 4, lower 2; subnormal or double-
 toothed Rodents Sub-order DUPLICIDENTATA.
- III. Upper incisors 2, lower 2; normal or simple-toothed
 Rodents Sub-order SIMPLICIDENTATA.

Next comes the question, How may the great group of the simple-toothed normal rodents be classed with reference to one another? This is answered by considering the types of structure respectively exemplified by the squirrel, rat, and porcupine.

Thus, any porcupine-like rodent is found to have the leg-bones (tibia and fibula) distinct from each other throughout, and this character is always associated with a peculiar shape of the lower jaw-bone; with a single exception, the back teeth are $\frac{3}{2}$ (*m.* $\frac{3}{2}$; *pm.* $\frac{2}{2}$); while, however various the general aspect may be, the muzzle is hairy, and there is a sigmoid or otherwise linear shape of the nostrils. These and other characters mark such animals as a natural alliance, which has been called the Hystricine series (*Hystricomorpha*).

Again, any rat, mouse, or related rodent is found to have the tibia and fibula united into one bone in the lower portion of their extent, and to have a special shape of the jaw-bone, unlike that of the porcupine; the back teeth, however variable, are normally only $\frac{3}{2}$; and the muzzle is naked to some extent, with a cleft upper lip and comma-shaped nostrils. The very numerous rodents which show these characters, almost without exception, constitute the Murine series (*Myomorpha*).

Once more, the squirrels and their relatives display a third set of characters, consisting essentially in the combination of such leg-bones as the Hystricines have, with the shape of the jaw of the Murines; the back teeth always more than 8, which is the normal murine number, yet the muzzle finished off as in Murines, never as in Hystricines. It is this combination of characters which enables us to range them all in a Sciurine series (*Sciuromorpha*).

We will now proceed to a consideration of these sub-orders and series.

SUB-ORDER I. — RODENTIA HEBETIDENTATA.

Though it may be a question, whether the fossil animal upon which this sub-order and the family MESOTHERIDÆ have been established is truly a rodent, we give it the benefit of the doubt, especially as there is no other order to which it can be assigned.

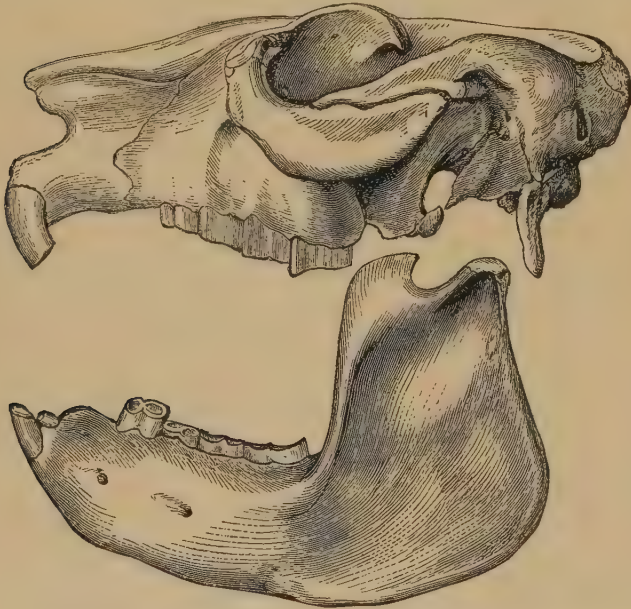


FIG. 30. — Skull of *Mesotherium cristatum*, about one-fourth natural size.

This gigantic rodent inhabited the pampas of La Plata in South America during the pliocene age; it was discovered by M. Bravard, and named *Mesotherium cristatum* by M. Serres in 1857. The upper incisors are two, as usual; the under are four, the outer ones quite small; and none of them present chisel-edges, wearing down more like the nippers of a horse, in consequence of being enamelled alike on both faces. The grinders are five above and four below on each side, two of the former and one of the latter being presumably premolars; they are all

rootless, simply constructed, with one re-entering enamel-fold; their series is curved, with the convexity outward. To these dental characters, unique in Rodentia, is added another, equally exceptional in this order; the long axis of the condyle of the lower jaw, and consequently that of the glenoid fossa, being crosswise instead of lengthwise. The skull is very massive, with enormous sagittal and occipital crests, the latter continuous with the ridge of the heavy zygoma, which rises behind as high as the top of the skull, and then sinks deeply as the malar passes forward to the lacrymal. There are a large bony palate; postorbital processes; long paroccipital processes; perfect clavicles; a fibulo-calcaneal articulation; five digits on each foot; and the claws were probably stout and hoof-like. Alston remarks of the singular animal that its affinities to the more aberrant hoofed quadrupeds, especially Toxodontia, must not be overlooked; and that it appears to be a survivor to pliocene times (when Rodentia had become well-established) of a much earlier type, which represented

an era when the rodents were not clearly marked off from their allies. "In fact, *Mesotherium* seems to continue *into* the order Glires, [Rodentia] that line of affinity which Prof. Flower has pointed out as extending from the typical Ungulates through *Hyracodon*, *Homalodontotherium*, *Nesodon*, and *Toxodon*."

SUB-ORDER II.—RODENTIA DUPLICIDENTATA.

Turning at once from the uncouth and monstrous rodent of the pliocene just noted, we enter upon the second sub-order of the Rodentia, consisting of the single series of the hare-like or Leporine gnawers, than which no animals are more familiar or better known to most persons. There being but one alliance in this sub-order, the series LAGOMORPHA is practically coincident with the sub-order Duplicidentata. It contains only two families, Leporidae and Lagomyidae, each of a single living genus, *Lepus* and *Lagomys*; while fossil genera of each, such as *Palæolagus* and *Titanomys*, carry our knowledge of these forms back in geologic time to the miocene period. There are some forty living species, chiefly of the Leporidae.

The Lagomorpha are distinguished by the presence of four incisors in the upper jaw. At an early age, indeed, there are six, but the outer one on each side is soon shed. The extra pair are smaller than the principal middle ones, and placed directly behind them, so that only two appear in front, as usual in the order. There are only two in the lower jaw, as usual. These teeth are enamelled to some extent behind as before, so that they do not wear to as sharp an edge as those of other rodents. The grinders vary in number, from $\frac{5}{5}$ in Lagomyidae to $\frac{6}{6}$ in Leporidae. The skull is remarkable for its numerous vacuities, among them an opening between the eye-sockets of opposite sides; the bony palate is reduced to a stout narrow bar across the molar region; the tibia and fibula are united below, and the latter articulates with the calcaneum. By these principal characters, to which some of less consequence might be added, the Lagomorpha may be readily distinguished from other Rodentia. The two families which compose this series may be discriminated with equal facility.

The dentition of the Family LEPORIDÆ, embracing the hares and rabbits, presents the largest number of teeth in the order, the formula for the adult being: *i.* $\frac{1}{1}\frac{1}{1}$, *pm.* $\frac{3}{3}\frac{3}{3}$, *m.* $\frac{3}{3}\frac{3}{3}$, = $1\frac{1}{2}$ = 28. The milk dentition is *i.* $\frac{1}{1}\frac{1}{1}$, *dm.* $\frac{3}{3}\frac{3}{3}$ = $1\frac{1}{2}$ = 18. The grinders are all alike rootless, and mostly tri-laminate; the incisors are less curved and less deeply rooted than usual in the order, and less colored in front, or entirely white. The skull is large, compressed behind, with convex frontal profile; the sides of the upper jaw are sieve-like, from a multitude of perforations; the frontal bone develops large flaring supra-orbital processes; the zygoma is nearly straight, and but little produced behind the glenoid fossa; the nasal bones and orbits are large. The coronoid process of the lower jaw is rudimentary, as such being represented by a thin narrow plate, and the angle of the jaw is a broad plate, not well distinguished from the ascending ramus. The collar-bones are present, but incomplete; the acromion process of the scapula is forked; the tibia and fibula are united, as in murine rodents. There are various other structural characters. The well-known external peculiarities are numerous, prominent among them being the disproportionate length of the hind limbs, and the size of the ears, which approximately equal or exceed the head in length. The gait is saltatorial when the animals are at full speed, and the erect attitude is frequently assumed, the whole length of the instep (metatarsus) being applied to the

ground. The soles are furry; the fore feet have five digits, the hind only four; the former are never used like hands to convey food to the mouth, as is done by so many other rodents. There are no cheek-pouches, but the inside of the mouth is partly furry. The nose-pad is prominent and very mobile, and the upper lip so deeply cleft that one of the sad deformities of the human race receives the popular name of "hare-lip." The head is somewhat globose, with large full eyes, which develop a third eyelid at the inner corner. The tail is short, though really longer than it appears to be, as it is bushy and habitually recurved over the rump. The male organs are permanently external; there is a peculiar perinæal sac, into which the ducts of certain glands enter. The mammae are numerous — about five pairs; the uterus is completely double, and its traces in the male are evident. The length of the spinal column in the lumbar region is remarkable, and the vertebræ of the loins are about seven in number, with long transverse processes slanting forward. The radius and ulna are complete, but do not permit rotation of the fore foot. The skin is remarkably thin and tender; the fur soft and woolly; neither the hide nor the pelage possesses much value, except to the animal itself.

Several extinct genera and species of hares are described, chiefly from the miocene and later formations of North America; but only one of these, *Palæolagus*, is sufficiently well-known. The existing species, to the number of thirty, perhaps, are so closely related to one another as to be properly referred to the single genus *Lepus*. They inhabit most parts of the world, but are absent from the Australian region. One species, the polar hare (*L. timidus* var. *arcticus*) dwells amidst the desolation of the most hyperborean regions. South America is the poorest in hares, having but one small species, called the Tapeti (*L. brasiliensis*). India and Africa have several. The family is best developed in North America, where no fewer than twenty species and varieties occur, illustrating the whole range of variation of size and form to which the genus attains, from the smallest and chubbiest "rabbit," to the largest and most "raw-boned" hare; as well as all those differences of habit which are impressed upon the creatures by their surroundings, — some burrowing in underground retreats, others squatting in their "forms" in scanty herbage; some inhabiting dense swamps, marshes, and cane-brakes; others woodland and dry tangle; others the sterile wastes of prairie or desert, and others, again, the recesses of Alpine solitudes. The preponderance of species is largely in the Northern Hemisphere; and one at least, the arctic form of the common *L. timidus*, is of circumpolar distribution, the American animal being only varieties distinguished from the Europæo-Asiatic.

The two best-known species — those which illustrate fairly the little difference which obtains between Hares and Rabbits — are *L. timidus* and *L. cuniculus* of Europe. The latter is the rabbit, properly so-called, and the only member of the family to which the name is strictly applicable. The name of "cony" has often been applied to the animal. This is from the Latin *cuniculus*, noting the burrowing of the rabbit in holes, and reappears in many modern languages. But the Biblical animal, which our translators saw fit to call "cony," is now supposed to be a very different species, the *Hyrax*, of the order Hyracoidea. The rabbit is rather small, some sixteen or seventeen inches long from nose to root of tail, with comparatively short ears and limbs; grayish-brown, the back of the neck rufous, and the upper side of the tail blackish; the under parts white, and no black space on the ear. It is a burrower, as its name implies, preferring light, dry, sandy soil; but is able to accommodate itself to a great variety of surroundings. This animal is supposed to be indigenous to Southern Europe, especially

Spain, the very name of which country is believed to signify the "land of conies." In some European countries the creature is so abundant as to become a pest. It is very prolific, having several litters a year, and bringing forth five to eight young, which are born blind, naked and helpless, in a warm nest under ground, furnished with fur from the parent's own body. This animal has been transported to various parts of the world, even to the island of Terra del Fuego; it readily naturalizes anywhere, and multiplies prodigiously. It is the original of the various breeds of pet rabbits, which



FIG. 31. — *Lepus timidus*, hare.

are found of all colors, and otherwise greatly modified in size, form, and kind of pelage. Some breeds attain an immense size; others acquire a long, fleecy fur, as the Angora; in others, the large ears fall down in various ways, known to rabbit-fanciers as the horn-lop, half-lop, oar-lop, and perfect lop. Some furnish the best cases of albinism, established and perpetuated, being snowy-white, with pink eyes; others are piebald, or silver-gray, or black.

This brings up the subject of the natural change of pelage of some species from

colored to white. However variously interpreted by naturalists, according to their respective views of species, the facts would appear to be as follows: The common hare of Europe, Asia, and America (*L. timidus*) has an immense range; it varies with its geographical distribution; those individuals which turn white, or nearly white, in winter, are called varying hares (*L. variabilis*) in the Old World, and polar hares (*L. arcticus*) in the New. The most perfect instances are those of the latter, in which the animal becomes snow-white, with black tips to the ears. More frequently, in the Old World, the change is not complete, there remaining tawny shades on various parts, particularly the ears and limbs. *L. timidus* proper—that is to say, the common hare, in latitudes where it does not turn in winter—is nearly two feet long; the ear nearly five inches high; the hind foot about five and two-thirds inches; the tail, including the hairs, four

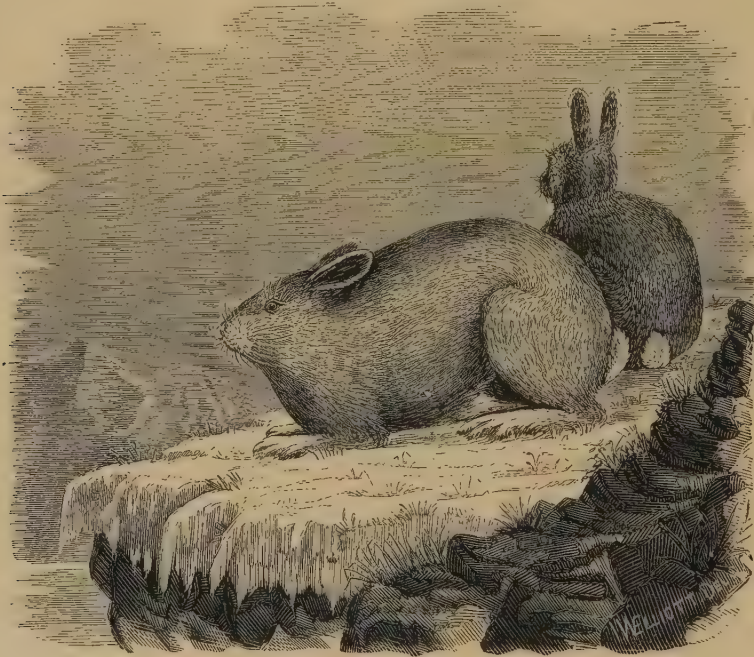


FIG. 32.—*Lepus americanus*, var. *bairdi*, American varying hare.

inches; the fur of the upper parts mixed black and brownish-yellow; the top of the tail, and the tip of the ears, black; the back of the neck and outside of the limbs rufous; inner side of the limbs, under side of the body and tail, white. Such an animal as this, in regions where it turns white or partly so, becomes rather smaller and more compact, with shorter ears and limbs, and heavier pelage, which is lighter colored in summer than that of *L. timidus* proper. This is *L. "variabilis,"* occurring from the Alps, Ireland, Scotland, etc., and through northerly parts of Asia, to the Arctic ocean; while in North America the same animal recurs, of superior size, and perfect purity of winter color, as the Polar Hare, *L. "glacialis"* (*L. timidus* var. *arcticus*). This is the only instance of specific identity of hares of the Old and New World.

In North America *L. timidus* is replaced by a perfectly distinct species of varying hare, *L. americanus*, of extensive distribution in northerly, alpine, and middle portions of the country, from Atlantic to Pacific. It is a "varying" hare in two senses. It

runs into several geographical races — var. *americanus* being northerly, of general distribution; var. *virginianus* more southerly, in the Eastern United States; var. *washingtoni*, of Oregon and Washington Territories; and var. *bairdi*, of the Rocky Mountains of the United States, as far south at least as Colorado. Each of these is distinguished in summer by the shade of the coloration, and each whitens to some extent in winter, though not completely.

There is only one other North American hare which whitens in winter. This is a perfectly distinct species, the Northern Prairie Hare (*L. campestris*) of the prairies of the West, as far south as Colorado at least, and north into British America. It is dis-



FIG. 33. — *Lepus campestris*, northern prairie hare.

tinguished, among other things, by having most of the upper as well as the under side of the tail white; the general coloration is pale sandy, with black ear-tips, and the winter bleaching is extensive, though never perfect. This is one of the largest of the hares, and may be taken to illustrate the remarkable group of several Western species so well known as Jackass Hares, or Jack-rabbits, from their size, and length of limbs and ears. Other species of this kind, to which the same name is applied, are *L. callotis* of Texas, New Mexico, and Arizona, and *L. californicus* of California. In these the tail is black above, and the pelage is never white. The speed of these great prairie hares, and especially the great distance they clear at a bound, is marvellous; while their attitudes and general aspect are no less singular. Like most large Leporidae, these do not burrow, but construct a "form" in the herbage, in which they squat; though all of them take to holes when coursed by hounds. Another large species,

but of very different character, is the Swamp Hare of the Southern States (*L. aquaticus*).

Leaving now the long-limbed creatures of great stature, we turn to some smaller and "bunchier" kinds, more nearly resembling the European rabbit. The best known of these—one too well-known to require extended description—is the Wood Rabbit, or "Molly Cotton-tail" (*L. sylvaticus*), so abundant in the United States. There is an apparently endless question whether this is a "hare" or a "rabbit." We have already seen that "rabbit" is a proper name, applicable in strictness to *L. cuniculus* alone, but, in this country at least, it has lost its original significance, and come to be applied indiscriminately to nearly all our numerous species,—even to the very largest of them, like *L. campestris*; being too firmly established in our vernacular to be eradicated. The question is, therefore, an idle one. But it may be observed, that if the name

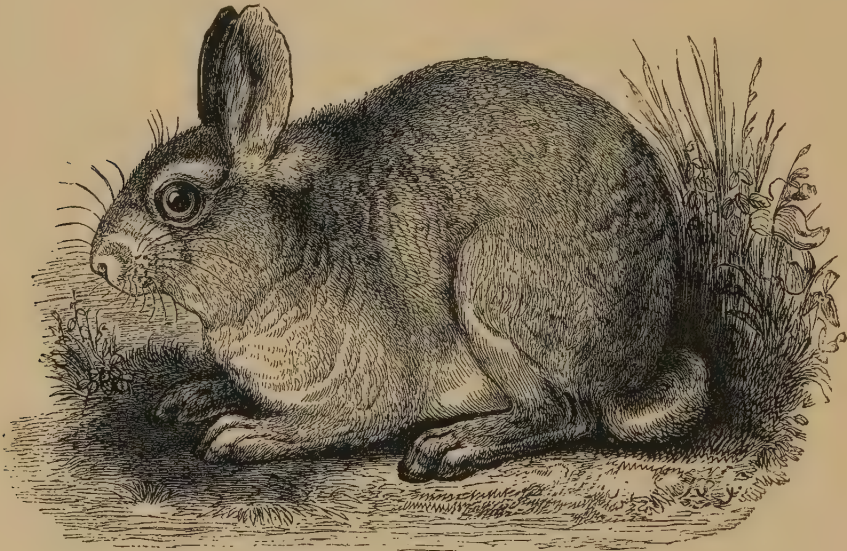


FIG. 34. — *Lepus sylvaticus*, wood-rabbit, Molly Cotton-tail.

"rabbit" be eligible for any of our species, it is most apt for those small, short-limbed and very prolific ones, which burrow more or less habitually, like the cotton-tail; these being thus most like *L. cuniculus*. Various animals of this kind inhabit North America; even the South American tapeti belongs to the same large group of small species. The only one of them in the Atlantic States, besides the cotton-tail, is the marsh rabbit, or marsh hare, as you please,—inhabiting the coast line of the Southern States. This is *L. palustris*; a very distinct species, much modified from *L. sylvaticus* by its aquatic habits. In the great West, a very abundant and almost universally distributed species, on the prairie, desert, and especially in sage brush country, is the little creature everywhere known as the Sage Rabbit (*L. artemesia*). It would appear to be only a variety of *L. sylvaticus*, somewhat changed by its surroundings. Other species and varieties occur in the Southwest.

Numerous well-marked forms of various regions of the Old World must be passed over. But probably the North American ones which we have noticed sufficiently illustrate the whole of them. The larger kinds, as a rule, are less prolific than the smaller ones, averaging probably less than five at a birth; they are apparently better developed

at birth, and produced rather in forms than in burrows. The same element of size and length of limb also appears in the gait of hares. In all the movements are peculiar, in consequence of the shape of the body. When moving slowly, the fore feet are held close together, and may be advanced one after the other; when, after a certain elongation of the body, the wide-spread hind limbs are brought far forward, with a peculiar doubling under of the body, and arching of the back. As the speed increases, it becomes more of a gallop, the long-barrelled creatures alternately extending and flexing the trunk, by the powerful muscles of the back and loins advantageously acting as tractors upon unusually long processes of the dorsal and lumbar vertebræ. But the smaller species have a gait which may be best described as "scuttling," strikingly different in appearance from the prodigiously free, high, and elastic progress of the jack-rabbits, such as *L. campestris* and its allies. We may also note a tendency of the smaller species to become gregarious, while the great prairie hares are thoroughly solitary animals. In fact, the whole economy of these animals seems to be very nicely graded, on the whole, from one extreme of stature and length of limbs and ears to the other; notable exceptions, however, are found in such species as *L. palustris* and *L. aquaticus*, which, though far apart in physical characters, have similar aquatic habits. The food, though various in detail, is substantially alike in all these congeneric animals, being strictly vegetable; succulent herbs, whether root, branch, or stalk, furnishing their usual fare. Though some species do much injury by gnawing and even girdling trees, this is exceptional. The dentition is weak (for rodents), and not to be compared in gnawing efficiency with that of many Rodentia, such as the beavers and the Arvicolinæ. The conformation of the fore limbs prevents the use of the paws as hands, which is the rule in this order of animals. Aside from their employment in progression, the fore feet are scarcely called into requisition, except for striking in the weak combats of hares with their kind, or in the stamping and "drumming" they indulge in moments of excitement.

Possessing no courage, little cunning, and able to defend themselves against only the least menacing danger, it is well for this weak and ineffectual race that they are endowed with keenness of eye and ear, and extraordinary swiftness of foot. The large eyes glance in every direction; the great ears turn inquiringly to every quarter; the creatures are always on the alert, and become panic-stricken at the first alarm. Their strategy is nothing more than to sit motionless in their form, in hopes that danger, however imminent, may pass by; or to double on their tracks when hotly pursued. More insidious foes than man with dog and gun, and the whole array of carnivorous beasts, birds, and reptiles which pursue them, are the numerous parasites, — ticks, bots, and especially tapeworms, — which infest their attenuated thin-skinned bodies; and sometimes grievous epidemics of some unknown disease sweep them off by thousands. Yet they hold their own; and though their lot is not a happy one from any human standpoint, one has only to watch hares gamboling on the greensward in the moonlight, unconscious of peril, to feel that there are joyous moments in the lives of these timorous children of the earth.

Ascending mountains in many parts of the Northern Hemisphere to a height at which hares usually disappear, one is likely to encounter the Pikas, — poor relations of theirs. Sharp, squeaking notes resound from the rocks, and soon a glimpse may be had of a curious little creature, seeming more like a rat or guinea-pig than a rabbit, six or eight inches long, low-limbed, thick-bodied, with large rounded ears, and apparently

no tail. These are the Pikas, "Conies" "Chief Hares," and Crying Hares, as they are variously called, — all of the genus *Lagomys*, the only living one of the family LAGOMYIDÆ. The species are few, and apparently all closely related; they chiefly inhabit the boreal and alpine regions of Asia. Representative ones are the Europæo-Asiatic *L. alpinus*; the Asiatic *L. ogotona*; and the North American *L. princeps*.

Though outwardly so unlike hares in general appearance and economy, these little mountaineers betray their lagomorphic relations in numerous technical characters. Like hares, they have four upper front teeth; but the upper grinders are reduced by one on each side, the dental formula of *Lagomys* being *i.* $\frac{2}{2}$, *pm.* $\frac{2}{2}$, *m.* $\frac{3}{3}$ = $\frac{14}{12}$ = 26 instead of 28. (In the miocene genus, *Titanomys*, the grinders are reduced to $\frac{4}{4}$.) The skull is more depressed, not so contracted behind, and lacks the extensive perforations of that of Leporidæ, as well as the supra-orbital processes; the zygoma is produced backward beyond the glenoid fossa; the coronoid process of the mandible is represented by a small tubercle. The incisors are deeply grooved, and notched at the end. The clavicles are complete. The hind limbs are not disproportionally lengthened, and progression is therefore like that of ordinary rodents, as the rat, for example. The ears are large, but flat and orbicular; the eyes very small; the whiskers long and copious. The paws have four perfect fingers and a rudimentary thumb, which, however, bears a claw like the rest; the feet are four-toed; both palms and soles are densely furry, with naked callous pads at the ends of all the perfect digits. The muzzle is entirely hairy, with cleft lip. The pikas have been called "tailless hares," the tail being scarcely visible in life — a mere pencil of hairs, not held recurved. On the whole, the aspect of these curious little creatures is more like that of guinea-pigs than of hares. The fur is soft and dense, of subdued, blended coloration.

The American Pika, or "Little Chief" Hare (*L. princeps*), so-called from some notion of the Indians respecting it, is one of the best-known species, and may serve to illustrate the whole genus. It averages seven inches in length, with the tail to the end of the hairs scarcely an inch longer; the ear about an inch high and wide; the head two inches long; the forepaw 0.75 of an inch; the hind foot 1.20. The sexes are alike; the pelage on the upper parts is grayish-black for most of the length of the individual hairs, which are then ringed with yellowish, grayish, or pale-brown, and finally tipped with black, producing a dark grizzled color, which, on the under parts, gives way to a muddy whitish or ochrey, in which the plumbeous roots of the hairs appear; the ears are blackish, with a white rim; the whiskers black. This quaint little creature is found in colonies nearly throughout the mountains of the West, as far south as New Mexico and Arizona. In these latitudes it inhabits only the highest ranges, at or little below timber-line, and thence to the limit of vegetation; but as we proceed northward we find it comes down to four thousand feet at latitude 49°, and still further in British America. The favorite haunts are the masses of rocky *débris* at the heels of cliffs, where the animals find safe hiding-places among the boulders, and sometimes congregate in large numbers, making known their presence by squeaking notes which seem to issue from under ground, and are very deceptive as to distance. Though timid, they are unsuspicious of danger, and may frequently be seen perched upon the rocks, uttering their peculiar crying notes, or foraging quietly in grassy spots for their food, of which the provident creatures lay up great stores in their rocky granaries. Large stocks of provender, consisting of hay and other herbage, are often accumulated, probably by the work of more than one individual. Reproduction takes place in May and June, and about four young are produced in a grassy nest, among or near the rocks. It is curious to

see these quaint little quadrupeds issue from the rocks, and come inching along with a halting, jerky gait, advancing a few steps, then stopping to reconnoitre — their legs being so short that the creatures seem to move by some unseen machinery, like toy automata. Thus advancing, they gain a good post of observation on the edge of a rock, where they squat, throw up the head and erect the ears, while the belly contracts



FIG. 35. — *Lagomys princeps*, American pika, "Little Chief" hare.

visibly as the abrupt and explosive squeaking notes are, as it were, jerked out of their little bodies. The miners and hunters in the West know these oddities as "conies" and "starved rats."

SUB-ORDER III.—RODENTIA SIMPLICIDENTATA.

Now leaving behind the rodents which have more than two incisors above or below, we reach the series HYSTRICOMORPHA, or Porcupine-like Rodents, with the normal formula, $i. \frac{2}{2}$, which obtains in all the remaining families of this vast order. As explained in the beginning, the Simple-toothed Rodents are divisible into three series, according to types of structure represented by a porcupine, a rat, and a squirrel, respectively. The reader would, however, gain a very erroneous idea if he supposed that an animal to belong to the Hystricomorpha must necessarily resemble a porcupine in general aspect. The term simply implies agreement in certain essential particulars with that structure which a porcupine presents. A beaver is not more unlike a squirrel, or a mouse more unlike a jerboa, than are the numerous members of the Hystricomorpha dissimilar to one another in superficial respects. No fewer than seven distinct families, with numerous genera, compose this series. Any member of the series may be recognized by the persistence of the fibula as a separate bone from the tibia, in connection with certain cranial characters. The angular portion of the mandible springs from the outer side of the bony covering of the incisor; the coronoid process is small, and the condylar low; there is no distinct post-orbital process (except in one genus, *Chaetomys*); and other peculiarities of the skull might be added. Throwing out one genus (*Cteno-*

dactylus), which lacks premolars, the dental formula is the same throughout, being $i. \frac{1}{1}, pm. \frac{1}{1}, m. \frac{3}{3} = 18 = 20$. The muzzle is hairy, usually uncleft, with curvilinear nostrils. In external form there is the utmost diversity; from the great swinish capybara, largest of living rodents, to the delicate chinchilla; from the clumsy, prickly porcupine to various agile and furry creatures; while all modes of life—arboreal, terrestrial, aquatic—are exemplified. The hystricine rodents swarm in all their variety in the forests and on the pampas of South America, where they are among the most characteristic members of the mammalian class, focussing in Brazil. Excepting four remarkable outlying genera of Octodontidæ (*Ctenodactylus*, *Pectinator*, *Petromys*, and *Aulacodus*), which are Ethiopian, and the Old World porcupines of the genera *Hystrix* and *Atherura*,—the entire series of Hystricomorphs is absolutely confined to North and South America, and the West Indies; and even in the latter there are but three species, while only two inhabit North America. In geologic time, the series stretches back to the eocene. The fossil genera are also nearly all American; several have been described, though none appear to indicate families distinct from those now existing, and some of the genera are identical with those which have survived to the present day. We will pass the families in review, which, however, must be brief, as we can only dwell upon some leading form of each.

The gigantic Water Cavy, or Capybara (*Hydrochoerus capybara*), is the type and only living representative of the family HYDROCHÆRIDÆ, distinguished by certain cranial and dental peculiarities, but otherwise agreeing with the Caviidæ. This animal is by far the largest of existing rodents, attaining a length of over four feet, and a stature of some twenty inches. Its massive form, huge, flat, blunt head, and long, coarse, and scanty hair, together with the hoof-like claws, are swinish features peculiar to this great clumsy "water-pig." The limbs are short and stout; the ears and eyes small; the muzzle is remarkably broad; the tail a mere stump; the general color is brownish, becoming paler on the under parts. The weight may be a hundred pounds or more. The Carpinchos, as they are called by the natives, frequent the lakes and water-courses of the greater part of South America, but especially Brazil, living generally in small companies in the heavy vegetation of the banks, and taking to the water on alarm, where they swim and dive with ease, sometimes showing only the muzzle above the surface. The female is said to transport her young on her back. According to Mr. Darwin, the young are from one to four in number; others say five or six. These animals have little to fear, except from the jaguar or puma, of which they are the frequent prey. Their flesh being indifferent, they are not much hunted, and, in regions where they are little molested, sometimes become so tame that one may approach them within arm's length before they dash into the water with their peculiar cry, half-bark, half-snort.

At least one member of the family CAVIIDÆ is well known to every one under the misleading name of guinea-pig, universally applied to the domesticated animals, probably by confounding Guinea with Guiana; for all the cavies are South American. The family is characterized among its allies by the comparatively short incisors and other dental and cranial features. The clavicles are imperfect, and commonly said to be wanting. The tail is rudimentary, or very short; the fore feet are four-toed, the hind three-toed, both terminating in somewhat hoof-like claws; the upper lip is not cleft; the general form is different in the two genera, *Dolichotis* and *Cavia*, which compose the family. In some cases at least, if not in all, the young are remarkably precocious, shedding their milk-teeth before they are born.

Hydrochoerus capybara, capybara.



The Patagonian Cavy (*Dolichotis patachonica*) is a remarkable animal, with rather long ears and limbs, and an obvious, though very short, tail — altogether the most hare-like member of the family, resembling an overgrown rabbit as much as the capybara does a pig. The general aspect is rather like that of an agouti (of the next family but one) than of a cavy. Its length is from two and a half to three feet, and its standing height about a foot; the weight twenty or thirty pounds. The thick, crisp fur is rusty yellowish on the sides and limbs, gray above, blackening on the rump, where there is a transverse white band; the under parts are white. This singular animal abounds on the sterile plains of Patagonia, south to about 48°, and in the opposite direction reaches the La Plata country. It is shy and watchful, and generally observed at a distance, when two or three may be seen together, hopping leisurely along in single file. It lives in burrows, either excavated by itself or by the viscacha, where its young, generally two in number, are brought forth.

The genus *Cavia* includes numerous species, more or less like the common Guinea-pig in form, though none of the wild ones resemble the piebald (black, white, and tawny) individuals commonly seen in confinement. These are commonly supposed to be the modified descendents of the Restless Cavy (*C. aperea*), though by some described as distinct, under the name of *C. cobaya*. As piebald individuals were certainly known as such to Aldrovandus, writing not long after the discovery of South America, Dallas argues that the Restless Cavy, if the same as *C. cobaya*, must have been long domesticated in America prior to its introduction into Europe. It is stated by Rengger, however, that Apereas of the fifth or sixth generation from a single couple, domesticated for seven years, showed no sign of changing from their feral colors. The Rock Cavy of Brazil (*C. rupestris*), the Mountain Cavy of Bolivia (*C. boliviensis*), and the Southern Cavy (*C. australis*) of Patagonia, are species of a different section of the genus from *C. aperea*. In domestication, the guinea-pig is probably the most prolific of mammals; the periods of gestation and lactation being remarkably brief the litters large, and procreation almost continual.

A single genus and species, *Dinomys branicki*, of which only one specimen is known, is the basis of the lately established family DINOMYIDÆ, which combines in so remarkable a manner the characters of several groups of the hystricine series, as to serve in some sort as a connecting link between the cavies, agoutis, chinchillas, and octodons. Both fore and hind limbs are four-toed, with somewhat hoof-like nails; but from the paca, which it closely resembles in outward characters, it recedes by certain osteological and dental characters in the direction of the chinchillas, and some of the Octodontidæ. It is about two feet long, with a bushy tail nine inches long; in color a grizzled gray, from intimate mixture of white hairs among black ones, but adorned with two white stripes, and many white spots on the back and the sides, as in the paca, which, on the whole, it most resembles; the pelage is harsh; the body stout; the ears and limbs are short; and the upper lip is cleft, contrary to the rule in Hystricomorpha. The only individual known was procured on Montaña de Vitoc, in Peru; nothing has been learned of its habits, nor has it a known vernacular name.

The DASYPROCTIDÆ is the last family of the four South American ones which have hoof-like claws, and remind us more or less forcibly of pigs, as we have seen already in the case of the cavies and the capybara. As one author has remarked, the resemblance of the agoutis to the little musk-deer is still closer. The general form is rather

slender, especially in the limbs, which are of moderate length; the ears are short; the tail is very short, or quite rudimentary. The fore feet are five-toed. The two genera which compose the family are distinguished, among several external characters, by the number of toes of the hind feet—five in *Cælogenys*, three in *Dasyprocta*.

The skull of the Paca (*Cælogenys paca*) is a curiosity. The name of the genus, derived from the peculiarity, signifies “hollow-cheek,” but in the very opposite of the sense we usually attach to the term; for, instead of being sunken, the cheeks are remarkably plump. The hollowness is in the bone itself; the cheekbone (malar and continuous malar process of the maxillary) being extraordinarily inflated and excavated, and the outer surface being roughened in a peculiar manner. This apparent monstrosity is unique among mammals, and only surpassed by the state of the skull of *Lophiomys* (see beyond), which is still more anomalous, though in a different way. The cavity in the bone is lined with mucous membrane, and communicates with the mouth by a small opening. As far as being a side cavity connected with the mouth is concerned, the structure is a cheek-pouch; but being excavated in solid bone, it can hardly be used as many rodents use their pouches, for the reception of food. No food has been found in it, and the function of the singular structure is unknown. The possessor of this apparatus is an animal about two feet long, stouter-bodied than an agouti, with coarse, close-set hair, of a variable brownish color above, and white below, the sides with several longitudinal white bands, or rows of spots, or both; the head is large, broad and obtuse; the tail a mere fleshy tubercle; the inner toe on each foot, and its nail, very small, the others stouter and hoof-like. It ranges in Central and South America from Guatemala to Paraguay, east of the Andes. It is somewhat nocturnal, spending the day mostly in its underground retreats in the forests, and especially along water. Its burrows are several feet in depth, doubtless excavated by the animal itself. The female is said to produce only one or two young, though the mammæ are two pairs, pectoral and inguinal.

Numerous species of agoutis have been described, but the propriety of retaining some of them in the system is dubious. There are probably about eight, of which the Yellow-rumped Agouti (*Dasyprocta aguti*) is the best-known and most abundant; Azara's Agouti (*D. azaræ*) is another; while a smaller species than either, notable for inhabiting some of the West India islands, as well as South America, is the Acouchy (*D. acouchy*). The last-named is also distinguished by having quite a tail, some two inches long,—that member in the other species being rudimentary. Resembling the paca to some extent, these animals are smaller, the largest only some eighteen or twenty inches long, and not so stout-bodied; there are only three toes on the hind feet, and no cranial monstrosity. Lack of a tail, and the unusual length of the hairs falling over the rump, confer a singular appearance, as if the creatures were tucked in under behind. The coloration is not broken up into spots, but is generally some shade of brown, paler or white below, set off with rich yellowish, or even reddish, on the rump and some of the under parts. The agoutis inhabit woodland, but make frequent excursions into open country; they are agile creatures, running swiftly and with an easy motion. They pass much of their time in their retreats during the day, but at night ramble in search of food, usually leaving and regaining their homes by the same pathway, which they gradually wear for themselves. They eat almost anything of a vegetable nature, and are readily kept in confinement. The usual number of young is said to be two.



Dolichotis patagonica, Patagonian cavy.

Continual surprises are in store for the student of the Rodentia, who soon discovers with what cunning and ingenuity Nature elaborates similar models into the most diverse shapes, and fits creatures essentially alike in structure for very different modes of life. Mystification will certainly occur to one who for any reason pays insufficient attention



FIG. 36. — *Dasyprocta aguti*, yellow-rumped agouti, one-fourth natural size.

to those dry details from which one might turn with weariness, were it not for the assurance that such technical characters are the only safe guide in classification. For instance, in the CHINCHILLIDÆ we have a group of pretty little furry creatures, whose soft coats we are proud to possess and wear ourselves — squirrel-like animals of grace and agility, yet actually forming a link between the stout pig-toed rodents we have just considered and the uncouth prickly porcupines, which come next. The chinchilla family is composed of three very distinct genera, *Lagostomus*, *Lagidium*, and *Chinchilla*; which differ from one another in the number of their toes, and several more abstruse characters. In all the tail is of moderate length, or quite long and more or less bushy; the fore limbs are small and neat, with perfect clavicles, and the paws are serviceable as hands; the hinder limbs are elongated; the ears are prominent, in all but *Lagostomus* very large. These animals inhabit both mountain and plain.

The stout, able-bodied Viscacha (*Lagostomus trichodactylus*) bears exactly the same relation to the delicate chinchillas that the terrestrial marmot-squirrels (*Spermophilus*) sustain to their graceful arboreal cousins (*Sciurus*). It also plays, in South America, exactly the same part that the North American Spermophiles do in their own country; being, in fact, a terrestrial and fossorial chinchilla, whose burrows dot the ground of the pampas, and harbor owls of the genus *Speotyto*. The viscacha is nearly, or about, two feet long from nose to root of tail, this member being eight or ten inches in length, bushy and tufted; there are four digits on the fore feet, but only three on the hind. It bears no distant resemblance in form to some of the larger Spermophiles; the color is gray, mottled and pencilled with darker, white or yellowish on the under

parts, the head curiously striped with black and white,—the black stripe in the male formed of stiff bristly hairs. The ears are of moderate length. We cannot forbear to extract the following from Mr. Darwin's Journal: "The Viscacha is well known to form a prominent feature in the zoology of the Pampas. It is found as far south as the Rio Negro, in latitude 41°, but not beyond. It cannot, like the *Dolichotis patagonica*, subsist on the gravelly and desert plains of Patagonia, but prefers a clayey or sandy soil, which produces a different and more abundant vegetation. Near Mendoza, at the foot of Cordillera, it occurs in close neighborhood with the allied alpine species. It is a very curious circumstance in its geographical distribution, that it has never been seen, fortunately for the inhabitants, in Banda Oriental, eastward of the river Uruguay; yet in that province there are plains which appear admirably adapted to its habits. That river has formed an insuperable obstacle to its migration, although the broader barrier of the Parana has been passed, and the Viscacha is common in Entre Rios (the province between the two rivers), directly on the opposite shore of the Uruguay. Near Buenos Ayres these are animals exceedingly common. Their most favorite resort appears to be those parts of the plain which during one-half of the year are covered with great thistles, to the exclusion of other plants. The guachos affirm that it lives on roots, which, from the great strength of its gnawing teeth, and the kind of localities frequented by it, seems probable. As in the case of the rabbit, a few holes are commonly placed together. In the evening the Viscachas come out in numbers, and there quietly sit on their haunches. They are at such times very tame, and a man on horseback passing by seems only to present an object for their grave contemplation. They do not wander far from their burrows. They run very awkwardly, and when hurrying out of danger, from their elevated tails and short front legs, much resemble great rats. Their flesh when cooked is white and good, but it is seldom used."

It requires no great stretch of the imagination to fancy the species of the next genus, *Lagidium*, to be a cross between a squirrel and a rabbit, combining as they do the long ears of the latter with the long, bushy tail of the former. They are alpine chinchillas, with four toes on the fore feet (the true chinchillas having five), inhabiting the Andes of Chili, Bolivia, and Peru. There are at least two species,—Cuvier's Chinchilla (*L. cuvieri*), and the Pale-footed (*L. pallipes*). The former is about eighteen inches long, the bushy tail making nearly as much more; the hare-like ears are scarcely shorter than the head; the very soft fur is yellowish-gray above, pencilled with black, and showing a narrow black line along the back; the under parts are pale-yellowish; the tail is black underneath. In habits these animals agree substantially with the chinchillas.

If the foregoing be called rabbit-squirrels, the Chinchilla itself (*C. lanigera*) may be termed a pika-squirrel. Such an animal as we have described under *Lagomys*, fitted with lengthened ears and hind legs, and a long, bushy tail, would resemble a chinchilla. There also appears to be some general similitude in habits between these very different, yet equally alpine creatures, though the chinchilla, as might be expected from its more graceful shape, displays much greater agility than the pika in skipping about the rocky fastness it inhabits. The caprices of fashion have brought the beautifully thick, soft, and elegantly marbled dusky-gray fleece in great repute, and the little creatures have consequently been long subjected to cruel persecution. Chinchillas are only nine or ten inches long, and it takes many such small pelts to make a single garment for their oppressors. Notwithstanding this, they are so prolific as to hold their own in great abundance. The tail, in the small species under consideration, is about three-fourths as long as the body. A larger species, *L. brevicauda*, is described

as measuring about fourteen inches in length of head and body, with the tail only about five and a half. The general tone of the coloration is silver-gray. Both kinds are found in Peru, the smaller one ranging also in Bolivia and Chili.



FIG. 37. — *Chinchilla lanigera*, common chinchilla, one-third natural size.

Hitherto we have encountered no spiny rodents; but in these “fretful” animals, the Porcupines (French *Porc-épin*, or “Prickly-Porker”) of the family HYSTRICIDÆ, more or less of the pelage is converted into stout spines mixed with long hairs. These are usually quite short; but in some species they attain a length of eight, twelve, or even sixteen inches, and are cylindric, tapering, and parti-colored; being those objects so well known as fancy pen-holders. Such a singular armature furnishes the required protection to animals otherwise almost defenceless; for, when erected and bristling in every direction, such a *chevaux-de-frise* is absolutely impenetrable. The spines are loosely inserted in the skin — so loosely that they readily become detached; they may even be shaken loose by energetic muscular action, and those which are barbed stick readily in any object they penetrate. Here is the grain of truth in the traditional chaff, that the porcupine shoots its quills as it stands on the defensive, or lets fly Parthian arrows as it retreats from its pursuers. The writer has many times witnessed the actions of one of the porcupines (*Erethizon epixanthus*). In this creature the spines are very short, only about an inch long, but sharp and jagged at the point. The animal is slow, clumsy, sullen, and when captured makes no show of resistance beyond gathering itself in a heap, with the head and limbs drawn in as far as possible, and the back high-arched like that of an angry cat. The spiny tract is chiefly on the lower back and upper surface of the broad, lumpish tail. The latter is the chief weapon of defence; while the creature seems passive, it is all the while keenly watching the enemy, waiting for a

chance to let fly. Should one come incautiously within striking distance, he will probably feel hurt before he has time to discover that numerous quills are sticking in his clothes and person. There has been a vicious flirt of the tail, — a peculiar jerky slap, as if the thorny member worked on a spring hinge, — reminding one of the jumping of a spring-beetle (*Elater*). Should the animal be worried with a stick from a safer distance, repeated thrashings of the tail, each quick as a flash, betray its irritation; and after the *melée*, many of the quills lie scattered on the ground, having been flirled out in the convulsive action. The common species of European porcupine, *Hystrix cristata*, and others of that group, have a defensive apparatus additional to the foot-long quills above-mentioned. The end of the tail is furnished with a set of curious short, stout spines, open at the end, but inserted in the skin by a slender stalk. These quills rattle when the tail is shaken, doubtless sounding like a warning or a challenge to an enemy, and reminding one of the equally noisy appendage of the rattlesnake's tail.

There are two very distinct groups of porcupines, one inhabiting the Old World, the other the New. The former are ground porcupines, terrestrial and fossorial (sub-family Hystricinae). The latter are more or less arboreal (sub-family Sphingurinae), and in some of these the elongated tail becomes prehensile, to be hooked about the branches of trees like that of a monkey or opossum. There are other characters, such as the number of toes, together with some dental and osteological peculiarities. But the American tree porcupines are not exclusively arboreal. The genus *Erethizon* seems to connect the two groups, so far as habits are concerned; for *E. epixanthus* is found oftener on the ground than in trees, and has been observed on the prairie many miles away from the nearest timber. In none of the Sphingurinae do the quills attain anything like the dimensions seen in *Hystrix* proper. They are usually an inch or less in length, and when not bristled up are entirely concealed in the long, coarse hair. Some genera of the next family (Octodontidae) are quite as thorny as most of the porcupines.

The Hystricinae inhabit the Palæarctic, Indian, and Ethiopian regions. The typical genus, *Hystrix*, with several species, has the very long cylindric quills, and the rattle-box above described, together with many shorter spines. *H. cristata*, the Common Porcupine, some two and a half feet long, with a very short tail, inhabits Southern Europe and Northern Africa. The other genus is *Atherura*, comprising the Brush-tailed Porcupines of the Malay region (*A. fasciculata*), and also of Africa (*A. africana*); these are much smaller, with relatively longer tail, and quite short, channelled spines.

The semi-arboreal North American Porcupines constitute the genus *Erethizon*, with an Eastern (*E. dorsatus*) and a Western species (*E. epixanthus*). They are of large size, averaging about two and a half feet long, of ungainly form and ugly visage, extremely stout and clumsy body, short, strong limbs, terminating in large claws, of which there are five (not four, as usual in Sphingurinae) on the hind feet. The tail is not prehensile, but short, flattened, tapering to the obtuse end from a base so stout that no distinction of body and tail is perceptible. The upper lip is slightly notched, but there is no cleft, and the whole muzzle is hairy. The pelage below is short and soft; above, the animal is extremely hirsute, the long, coarse hair being mixed with small, sharp quills on the haunches and tail. Both species are found from the limit of trees at the north into much of the United States.

The South American tree porcupines are smaller and more perfectly arboreal species of the two genera *Chaetomys* and *Sphingurus*, in which the tail is longer and

Hystrix cristata, European porcupine.



more or less prehensile, and there are only four toes on the hind feet. These range over Central and South America, from Southern Mexico to Paraguay, east of the Andes. In *Chatomys subspinosus*, the type of the genus, we see the transition from hairs to quills, the body being clad with stout, wavy bristles. The numerous species of *Sphingurus* have the body clothed with short spines, or mixed spines and bristles; *S. mexicanus* is the northernmost; others of more extensive distribution are the Cændou (*S. prehensilis*) and the Couiy (*S. villosus*).



FIG. 38. — *Erethizon dorsatus*, North American porcupine, one-sixth natural size.

The remaining members of the Hystricine alliance are numerous and diversified, but present some common characters by which they may be grouped in one family, OCTODONTIDÆ. None are very well known, except to naturalists and to the natives of the countries they respectively inhabit; so that they have received no name familiar to English ears, with the exception, perhaps, of the Coypu, whose skin is an article of commerce, under the style of "Nutria fur." The Octodonts furnish, with the ground porcupines, the exceptions to the rule that the Hystricomorphs are peculiar to America, and, with the further exception of *Erethizon*, to Central and South America. Four genera are African; two are West Indian. The technical characters of the family are derived chiefly from the skull and teeth; but other features are so diverse that it will be best simply to notice the leading forms under the heads of the three sub-families into which they are divisible.

The first of these is the Echinomyinæ, or Hedge-hog Rats, as they may be collectively termed, from the circumstance that the pelage is usually harsh, or bristly, or even mixed with spines. In external form and aspect, however, as well as in habits, the numerous genera differ much. Thus, the remarkable African representative of the group, *Aulacodus swinderianus*, is a large burrowing animal, called by the natives "Ground-pig." It is nearly two feet long, with a stout body, and short ears, limbs, and tail. The pelage consists of harsh, bristly hair, flattened and grooved; the

general color is brownish. The incisor teeth are triply grooved. From this lumpish African animal we pass directly (technical characters being considered) to the West Indian representatives of the Echinomyinæ, of the genera *Capromys* and *Plagiodon*. The species of the former inhabit Cuba; of the latter, St. Domingo; the differences between these genera are chiefly anatomical, the external appearance being very similar. Both might be described as immense tree-rats, the general proportions reminding us of rats, though the tail is relatively much shorter. It is somewhat naked and scaly, and in one species, in which it attains its greatest length, acquires also some prehensile power, aiding the animal in its arboreal excursions. The Hutia-conga of the Cubans (*Capromys pilorides*) is the short-tailed species, about twenty inches in length, the tail being half as much again; the color is blackish and yellowish. The Hutia-carabali (*C. prehensilis*) is the other species, much smaller, and longer-tailed. The St. Domingo *Plagiodon cedium* resembles the former in proportions, but is nearer the latter in dimensions.

All the remaining Echinomyinæ are strictly South American. The most remarkable of them all, and the best known one, is the Coypu (*Myopotamus coypus*), in which the resemblance to the beaver is extraordinary. In fact, it represents the beaver among Hystricomorphs, affording one of the many cases in which an animal of one of the three great rodent series mimics and actually represents one of another series. The coypu is one of the larger rodents, about equalling a beaver in size, with a stout form, powerful organization, strong dentition, webbed hind feet, and thoroughly aquatic habits. The tail is partly naked and scaly; but differs from the flat paddle of the beaver, in being cylindric and tapering, like that of an otter. The coypu, in fact, might be likened to a beaver with an otter's tail attached; and this similarity seems to be noticed in the term "nutria," applied in commerce to the pelage, *nutria* being etymologically the same word as *lutra*, an otter. The coypu lives in burrows along in the banks of rivers, and even, in some places, on the coast; it swims freely, sometimes in the open sea, and may be observed at times carrying its young on its back, before they have learned to swim. The eminent monographer of the Rodentia, Mr. Waterhouse, considers that this habit explains the unusual position of the teats of the female coypu, which are situated on the sides of the body, above the middle line, behind the shoulder and before the thigh. But a more or less lateral and elevated situation of the nipples is a common character in the present family. It is scarcely necessary to add, that the beautiful brown fur of this aquatic animal, not unlike beaver or otter, has the very reverse of the quality implied in the name Echinomyinæ, being soft and dense, and forming an important article of commerce.

South America also yields a considerable number — over a dozen species — of small Echinomyinæ, referable to several genera. They are all of rat-like aspect, with much the general figure and bearing of rats, the ears and limbs, and especially the tail, being well developed. This member may equal or even exceed the head and body in length; it is seldom if ever much shorter, and may be either naked and scaly, or closely haired throughout, or even tufted at the end. In the genera *Echinomys* and *Loncheres*, comprehending some dozen species, the fur is usually mixed with more or fewer spines; the other genera are soft-haired. These spines are generally flattened, somewhat lancet-shaped, contracting suddenly at the base to a slender stalk to be inserted in the skin, gradually running to a sharp point at the end; they may, furthermore, be channelled or ridged. They do not project beyond the general surface of the fur. *Echinomys cayennensis* is the best-known species of that genus; it is not very dissimilar to

species of the Murine genus *Neotoma* in general aspect. Some of the *Loncheres* are very prettily marked, as the *L. cristata*, with its brown body and snowy crest and end of the tail; or the parti-colored *L. picta*. Related forms, all of which lack spines, are *Cercomys cunicularius* of Brazil, with a long, scaly tail, and curiously similar to the common house-rat; *Dactylomys typus*, with a scaly tail, longer than the head and body; and species of *Mesomys*, with a short, thickly-haired tail. The genus *Carterodon*, based upon a species (*C. sulcidens*) from the bone-caves of Brazil, but since found to have living representatives, completes the list of Echinomyinæ.

If the animals so summarily noted in the preceding paragraph be comparable in any way to rats (Murinæ), — and there is certainly foundation for the superficial comparison, — then the species which compose the next sub-family, Octodontinæ, may with the same propriety be likened to the voles or field-mice (*Arvicolinæ*). At any rate, the two groups fill, in Octodontidæ, the place occupied in Muridæ by the Murinæ and Arvicolinæ, respectively. With the exception of the remarkable outlying African genus *Petromys*, with a single species (*P. typicus*), which resembles those of the foregoing paragraph, all these South American Octodontinæ are chubby animals, with short tails and limbs, and generally short ears; of moderate stature, and terrestrial and fossorial habits. The dentition is powerful, with large, broad incisors, and generally rootless, perennial molars; the skull is heavy and angular. In many respects, therefore, they represent the Arvicolinæ in their own series. The genera (besides *Petromys*) are *Ctenomys*, *Spalacopus*, *Schizodon*, *Octodon*, and *Habrocoma*. In the two former of these, the mimicry of Arvicolinæ is particularly well expressed.

The Tuko-tuko (*Ctenomys brasiliensis*) represents a genus of which several species are described, of grayish or brownish animals, usually eight or ten inches long, with a tail of two or three inches, very stout form, small eyes, and rudimentary ears. The generic name is derived from a comb-like row of bristles with which the hind feet are provided. These animals are thoroughly fossorial, living in long galleries under ground, feeding chiefly upon bulbs and other roots, and being mostly nocturnal. In their economy they thus seem to repeat the habits of the *Geomyidæ*; while in size, shape, and general appearance they are strikingly similiar. Together with the single species of *Spalacopus*, *S. poeppigi* of Chili, an equally subterranean and nocturnal animal, they appear to fill, in South America, the physiological rôle performed by the species of *Geomys* and *Thomomys* in North America. They extend from Brazil to the very extremity of Patagonia, one of the species being named *C. magellanicus* from its habitat. The genera *Octodon* (which, though giving name to the present sub-family, and to the whole family we are considering, is not particularly conspicuous) and *Schizodon* are closely related, differing chiefly from each other in the tail, which is as long as the body, and bushy at the end in the former, shorter and close-haired throughout in the latter genus. The ears and limbs, like the tail, are better developed than they are in *Ctenomys* and *Spalacopus*; the body is less clumsy, and the activities of the animal are more notably varied. *Schizodon fuscus*, of the Southerly Andes, is the only species of that genus; there are several of *Octodon*, inhabiting Chili, Bolivia, and Peru, of which the Degu, *O. cumingi*, is the best known. One has been named *O. gliroides*; whether a good species or not, the name may serve to signalize a certain resemblance which the rather pretty species of this genus bear to dormice. All of the foregoing genera have the fore feet five-toed; the remaining genus, *Habrocoma*, is distinguished by having but four toes in front, as well as by the great size of the rounded ears; as the name indicates, the fur is extremely soft and dense, like the

fleece of a chinchilla. *H. bennetti*, the typical species, is of a subdued grayish color, rather larger than a house-rat, with the tail about half as long as the head and body, and close-haired throughout. *H. cuvieri* is a similar but much smaller species; both inhabit Chili.

There are, of course, the proper technical characters distinguishing these several genera; but in the necessity of passing them in rapid review, a better idea of the group may, perhaps, be given by the expressions used, than by any mere formulation of dental and cranial details.

The third sub-family of Octodontidæ remains to be noted in a word. This is the Ctenodactylinæ, so-named from the fringe of bristles on the inner toes of the hind feet (somewhat as we have seen in the genus *Ctenomys*). These animals have some relationships with the jerboas, though totally different in appearance. They inhabit Africa, where they are represented by only two genera, each of a single species — *Ctenodactylus massoni* of North Africa, and *Pectinator spekii* of the Somali country, — neither of which has any English name; the former is called Gundi by the natives. It is in this group that the Hystricine rule of four back teeth, above and below, finds its sole exception, *Ctenodactylus* having no premolars in either jaw, and the same teeth of *Pectinator* being minute. The gundi is about the size of a large *Arvicola*, with very small ears, and a mere stump of a tail; the hind limbs are lengthened over the fore. In *Pectinator* the ears are better developed, and the tail is of a moderate length.

The Hystricine series has left traces of its former existence nearly or quite through the tertiary period — Octodons, porcupines, chinchillas, agoutis, and cavies being all represented, some of them abundantly. The later fossils are identical with existing genera in many cases; and while other and distinct genera are also known, they are too similar to existing forms to throw much light upon the evolutionary history of the series. One of the capybaras, from the bone-caves of Brazil, was a great creature, some five feet long. Another *Hydrochaerus* (*H. æsopi*), from South Carolina, as well as some West Indian remains (*Loxomylus* and *Amblyrhiza*) referred to Chinchillidæ, show the former distribution to have been more extensive than it is now. Viewing the African outliers now living, and the Old World *Hystricina*, it would not be surprising if certain European fossils which have been referred to Octodontidæ were really such; but their position is very questionable. (See also beyond, under head of Castoroididæ.)

The MYOMORPHA is the largest series of the Rodents, owing to the great preponderance of the Muridæ, its central and typical family, the genera and species of which are, at the present time, far more numerous than those of any other family of the order; while the profusion of individuals of some of the species, and their extensive geographical distribution, combine to make them among the best known of mammals. The house-rat, or the common mouse, typify the family Muridæ, and to some extent the entire Murine series; but there are many families of Myomorphs besides Muridæ proper, some of them of very different aspects and economy; so that one would gain but an imperfect idea of the whole Murine series who should judge them by this particular standard. The jerboas, for example, or the mole-rats, or the pouched-gophers, or the pocket-mice, or the dormice, have but slight resemblance to ordinary rats and mice, and in some respects recall members of other rodent series. But one set of structural characters runs through all these disguises of outward form

and habits. The key to it is found in the combination of leg-bones (tibia and fibula) anchylosed below, which separates any Murine from any Sciurine or Hystricine; together with a certain shape of the lower jaw which distinguishes any Murine (excepting the Bathyerginæ) from any Hystricine. This shape of the jaw results from the springing of the angular process from the lower edge of that part of the bone in which the incisor is inserted. The molars are rooted in most genera, rootless in some; no premolars is the rule, but with many exceptions; in one genus (*Hydromys*) there are but two molars on each side, above and below, the whole number of teeth (twelve) being thus fewer than in almost any other mammal. Post-frontal processes, so prominent a feature in Sciuriforms, are here wanting. The clavicles are perfect (except in *Lophiomys*); probably in all cases the forepaws are serviceable as hands, and some of the species are as active as squirrels in climbing. The upper lip is usually cleft, with a small, naked and mobile muffle. The average size is small, under that of the house-rat; the musk-rat and the jumping-hares are the largest, while some of the Myomorphs are among the most diminutive of quadrupeds. The range of activities is wide and varied; species being arboreal, terrestrial, aquatic, almost subterranean; all modes of progression are employed, and the jerboas at least seem to skim the ground almost like winged creatures; but none of this series are provided with flying organs like some of the Sciuridæ and various other quadrupeds.

No fewer than nine families come under the Murine Alliance. We will begin with that one which exhibits some affinity with the Hystricine series, through the African representatives of that group last considered.

The jerboas, belonging to the family DIPODIDÆ, are kangaroo-like, in so far as the development of the hind limbs, and the extraordinary power of leaping which results, are concerned. The fore part of the body, and the fore limbs, are correspondingly reduced, and the tail is very long. The elongation of the hind limbs takes place chiefly in the metatarsus or instep, between the toes and the heel, this part of the limb making a slender shank. Other characters vary in the several very distinct genera which compose the family.

The Jumping Hare of South Africa (*Pedetes capifer*) is nearly as large as the common Hare (*Lepus timidus*), and so different from the typical jerboas as to form a separate sub-family, Pedetinae. The grinders are rootless, and there is one premolar above and below, making four back-teeth in all. The hind feet are four-toed, with stout, hoof-like claws; the tail is long, about equalling the body, and bushy throughout; and the ears are tall, like a rabbit's; the color too is somewhat similar. Hence the name of "jumping hare" bestowed by the colonists upon these strange creatures, which go trooping over the ground like so many kangaroos, clearing twenty or thirty feet at one prodigious bound.

In the true Jerboas (sub-family Dipodinae), the same saltatorial modifications are carried to the uttermost, with such result that the leaping of a jerboa with extraordinary velocity, and only an instant's elastic contact with the ground, seems more like flying than running; and even when going slowly there is something very curious in the way it walks on its hind legs. The jerboa, in fact, is more truly biped than any monkey, and even more so than a kangaroo, which latter is supported upon a tripod, the tail furnishing a third leg. The shank is reduced to a single cannon-bone by union of the metatarsals, and the hind feet have but three functionally-developed digits. The toes are stout, hairy, and padded underneath. One of the rarest osteological

modifications of mammals — the fusion of several vertebræ of the neck — is found in *Dipus*, as it is also in some of the sloths and whales. The molars are rooted; pre-molars are lacking below, and minute or rudimentary above. The incisors are vertically grooved. The skull is very broad behind, with enormously developed auditory parts (as in the similarly configured, but very different, kangaroo-mice of North America). The ears are long; the tail is longer than the head and body, slenderly cylindric, and tufted at the end. The species of *Dipus* are very numerous in warmer parts of the Old World, but not in South Africa, where the *Pedetes* replaces them; *D. ægyptius* is one of the best known. The usual size is six or seven inches, the tail more; the fur is of some sandy color above, white below.



FIG. 39. — *Dipus ægypticus*, jerboa, reduced.

Belonging to Dipodinae proper, but exhibiting the transition thence to Pedetinae, are the genera *Alactaga* and *Platycercomys*. In these there is a small premolar above, but none below, making the teeth of unequal numbers in the two jaws, contrary to the rule in rodents. The incisors are not grooved, the occipital and auditory regions of the skull less inflated. These genera share the cannon-bone and anchylosed cervical vertebræ of *Dipus*; but there are five digits on the hind feet, of which, however, the inner and outer do not reach the ground. In *Alactaga*, which includes several species of Asia, Arabia, and Northern Africa, the tail is extremely long, and tufted at the end like a jerboa's; the animals jump almost as well as jerboas, but also proceed leisurely on all fours. In *Platycercomys* the hind legs are somewhat reduced, doubtless with corresponding decrease of saltatorial power; and the tail is flattened and uniformly covered with short hairs, not tufted.

All the members of this curious family live on the plains and deserts, and are more or less gregarious, trooping about together, and finding their retreats in underground burrows, the galleries of which are often of great extent and intricacy, and occupied by several individuals.

The family ZAPODIDÆ is framed to accommodate a single genus and species, *Zapus hudsonius*, the well-known Jumping Mouse of North America. Agreeing in many respects with the true Muridæ, it is modified for saltatorial progression, somewhat after the manner of the Dipodidæ. The cervical vertebræ are not anchylosed, nor are the metatarsal bones confluent. The molars are rooted; there is a small premolar

above, but none below. The skull is mouse-like, in that the auditory parts are not specially developed. All four feet are five-toed, but the thumb is rudimentary, with a flat, blunt nail. The animal is about the size of the house-mouse, but enlarged behind, with long legs for leaping; the tail is very long and slender, exceeding the head and body in length, and scant-haired, so that the scales show, like those of a mouse's tail. The ears are well developed. There are internal cheek-pouches. The pelage is coarse and hispid, of a light, sandy-brown above, darkened along the back with a mixture of blackish hairs; the under parts are white. The length of head and body is about three inches, that of the tail five, but very variable. This interesting little animal



FIG. 40. — *Zapus hudsonius*, jumping mouse, natural size.

inhabits the greater part of North America from Atlantic to Pacific, as far north at least as latitude 62°, but chiefly in wooded regions. When alarmed it makes off in a series of astonishing flying leaps, clearing eight or ten feet at a bound, but when moving leisurely, proceeds on all-fours, like an ordinary mouse. In winter it hibernates, like a dormouse. Professor Tenney has given us the particulars of a case in which he found one in January, in a grassy nest about two feet under ground, apparently dead, coiled in a close ball with the tail wrapped tightly around it. Taking it in charge, he produced an alternation of activity and torpidity, by subjecting the little creature to varying temperatures. The female brings forth two to four young in her underground retreat.

Here we must pause for a moment to consider certain fossil genera, the position

of which is, perhaps, not fixed, but which the highest authority upon the rodents, Mr. Alston, has associated together in a family, THERIDOMYIDÆ, and located here. Though they were at first variously classed and widely separated, the form of the jaw shows them to have been perfectly myomorphic, and they were, in Mr. Alston's judgment, related to the Dipodidæ. They are *Theridomys*, *Archæomys*, and *Issidioromys*, from the eocene and miocene of Europe. We, however, adopt the family only provisionally.

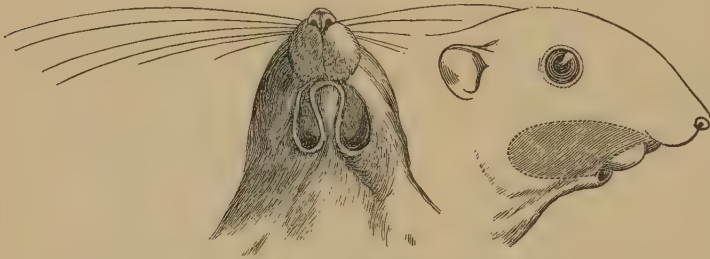


FIG. 41. — Cheek pouches of *Dipodomys ordii*, natural size.

These antiquated relics disposed of, the transition is easy from the jerboas through the spring-mouse to some very singular and interesting American animals forming the family SACCOMYIDÆ, or Pocket-mice,

a number of which are jerboa-like or kangaroo-like, in so far as they are hopping-mice of highly creditable accomplishment in that line of activity. In their technical character, however, they differ extremely, and their closest affinities are with the heavy lumbering underground rodents of the following family. They share with the Geomyidæ a feature unique among mammals—that of large *external* cheek-pouches, situated entirely outside the mouth, formed of an infolding of the skin of the head and neck, and being hairy inside as well as out. Hence

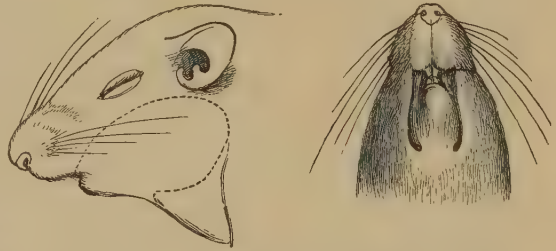


FIG. 42. — Cheek pouches of *Perognathus fasciatus*, natural size.

the name of pocket-mice, applicable to the whole family; though those of them that leap, particularly the species of *Dipodomys*, are generally called kangaroo-rats in the regions they inhabit. The pockets are common to all members of the family, but other characters are modified through the several genera in the direction of the Geomyidæ.

In *Dipodomys*, which stands at one extreme, the hind limbs are greatly elongated; the whole figure is thoroughly jerboa-like, and the skipping of the creature on its hind legs, like a flat stone over the water, recalls a jerboa perfectly. The tail is rather longer than the head and body, close-haired, but tufted at the end. The skull is extremely light and papery, with enormously developed auditory parts; the grinders are $\frac{4}{4}$ (one premolar above and below), rootless; the incisors narrow, deep, grooved. Some of the cervical vertebræ are anchylosed, as in *Dipus*; and it is curious to note how, in two different families, great elongation of the hind legs is accompanied by this abnormal condition of the vertebræ, and a peculiar expansion of the auditory parts of the skull. The fore paws have four perfect digits and a rudimentary thumb; the palms are naked; the hind feet have the digits in like case, but the soles are furry like a rabbit's, and the rudimentary toe is half-way up the long shank. *Dipodomys*

phillipsi, or *D. ordi*, is one of the most elegant and curious of our quadrupeds; fawn-colored above, snowy-white below, with white feet and a broad, white band on the hips; the tail blackish, but with a white stripe on each side. The fur is peculiarly



FIG. 43. — *Dipodomys ordi*, Ord's pocket-mouse, two-thirds natural size.

fine and silky; the eyes are large and expressive; the whole aspect betokening activity both of mind and body. This pocket-mouse is chiefly nocturnal in its habits, and burrows in the ground. It is common in southwestern parts of the United States.

Through the genera *Perognathus* and *Cricetodipus*, we pass by a very gentle



FIG. 44. — *Perognathus fasciatus*, natural size.

transition to the opposite extreme in the family — in fact, almost to the Geomyidæ. The several species of *Perognathus* (as *P. penicillatus*, *fasciatus*, and *hispidus*) express the foregoing characters in diminishing degree. The hind limbs exceed the fore by little if any; the inner hind digit is better developed and lower down; the soles are

naked or scanty-haired, and the pelage is comparatively coarse and hispid. The molars are rooted. Still, the skull is thin and light, the incisors are narrow and grooved, and the general style is *Dipodomys*-like, especially in *P. penicillatus*. This is of about the size of a house-mouse, with a very long, tufted tail; it inhabits a limited area in the southwestern Territories. *P. fasciatus* is a larger, stouter, shorter-tailed species, nearly equalling a chipmunk in dimensions. The related genus, *Cricetodipus*, contains one or two very diminutive sandy-colored, white-bellied creatures, *C. parvus* and *C. flavus*, scarcely two inches long, with a tail of about the same length; the ears very low; the pelage very fine, silky, and glossy. These queer little nixies are of extensive distribution in Western America, from 49° at least into Mexico. You may find them anywhere on turning over brush-heaps, or, if you are camping out, in the disturbance of the ground incident to pitching camp; or one may be caught in the huge pitfall which a camp-kettle represents to such small game. Little is known of the domestic economy of *Perognathus* and *Cricetodipus*. They all share a peculiarity of coloring, in having a fawn-colored stripe along the side, where the darker color of the back falls to meet the snowy-white of the under surface.

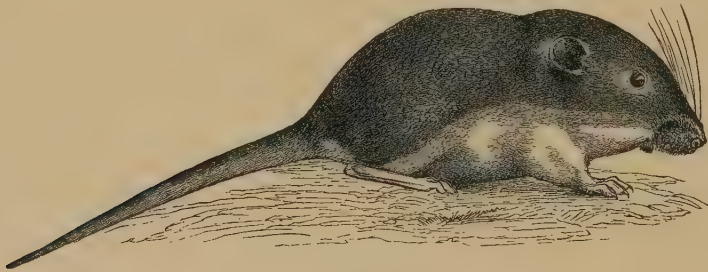


FIG. 45. — *Cricetodipus flavus*, natural size.

We have seen that the pelage is coarse and hispid in species of *Perognathus*. This, carried to an extreme, gives us spines in the harsh fur of *Heteromys*, the only remaining genus of this family. The whole conformation is further altered in the direction of *Geomyidæ*, in correspondence with more decidedly fossorial habits. The skull is heavier; the incisors are broad and smooth in front; the molars are rooted. There are numerous species of these prickly Pocket-mice inhabiting Mexico, Central America, and some of the West Indies; but they have not as yet been sufficiently worked out.

There is another exclusively American family, *GEOMYIDÆ*, in which the characters foreshadowed in *Heteromys* are carried to an extreme of fossorial capability, with, probably, as completely subterranean habits as any rodents have. The Gophers, as they are called, live as much underground as moles do, being but rarely observed, even where they abound. They are very stout, loutish creatures, with powerful fore limbs, no obvious neck, blunt head, rudimentary ears, very small eyes, and a thick tail, much shorter than the body. In size they average, perhaps, that of a large house-rat; but some species are nearly as large as a muskrat; others only that of a half-grown house-rat. The skull is massive and angular, its whole structure sturdy; there are four back-teeth on each side, above and below. In the genus *Geomys* the fore paws and enormous claws are pre-eminently fossorial; the upper incisors are grooved in different ways in the several species. The pelage is usually soft, sleek, and mole-like. The range

of this genus is from British to Central America, east of the Rocky Mountains, and in the Southern States. *Geomys bursarius*, the Pouched Gopher, is the commonest and best-known species, with the front teeth doubly grooved, the fore claws and pouches at a maximum. These great skinny bags reach back to the shoulders, and easily admit two or three fingers of one's hand. This animal, such a pest to farmers in most of the Mississippi Valley, where the ground is undermined by its excavations, and the isolated piles of loam it brings up are scattered everywhere, is of a muddy brownish color, grayer below, from six to nine inches long, with the tail two or three inches; the fore feet about an inch and a half, including the claws, the longest of which is



FIG. 46. — *Geomys bursarius*, pouched gopher, reduced.

about an inch. The very similar species of the South Atlantic States is *G. tuza*, chiefly distinguished by the mode of sulcation of the incisors, and the nakedness of the feet and tail. Species with the incisors single-grooved are a small one of Texas and New Mexico, the chestnut-cheeked (*G. castanops*), and two large ones of Mexico and Central America (*G. mexicanus* and *G. hispidus*). The former of these has the pelage soft and sleek, and, as usual in the genus, of a chestnut-brown color; its length is ten or eleven inches; and the incisors are visected by a medium-groove. In the Quachil (*G. hispidus*), the maximum size of nearly or about a foot in length is attained; the pelage is hispid and lustreless; the feet and tail are nearly naked; the incisors have a deep groove lying wholly in the inner half of the tooth. In no species of *Geomys* have I found more than three pairs of teats — two pairs inguinal, one pair pectoral.

Thomomys is chiefly distinguished by the smooth incisors, which usually have,

however, a fine impressed line margining their opposed edges; the feet are not armed with such immense claws, but the pouches are, if anything, relatively larger; the ears are better developed, though still only a mere rim. There appears to be six pairs of teats — two pairs inguinal, pectoral, and axillary, respectively. *T. talpoides*, the Mole-



FIG. 47. — *Geomys mexicanus*, Mexican gopher, reduced.

like Pocket-rat, is the representative species, extremely variable in size and color, running into the geographical races called *bulbivorus* and *umbrinus*, according to the range. It is six or eight inches long, with a tail of two to three inches; in color ranging from the grayish of the house-rat to a rich chestnut-brown, or even reddish, the feet, tail, and mouth parts usually white. Southern specimens are the smallest and



FIG. 48. — *Thomomys talpoides*, var. *umbrinus*, pocket-rat, a little reduced.

brightest colored. The general range is from Hudson's Bay and the Mississippi Valley (in a broad sense) to the Pacific and into Mexico. A smaller species, under six inches in length, and the tail scarcely one-fourth as much, is described from the Rocky Mountains (*T. chusius*).

The name gopher, a corruption of the French *gaufre*, is universally applied to

these animals collectively; but in the Western Territories various ground-squirrels receive the same designation; which, in the South Atlantic States, where *Geomys tuza* is known as the Salamander, is applied to a kind of turtle. The gophers are fond of the richest, softest, and most loamy soil, where their interminable mining operations are peculiarly disastrous to the agriculturist. It is almost impossible to eradicate them. In the West, where gardens are cultivated by irrigation, I have seen them forced from their burrows by turning a large stream of water into their holes; but this method is obviously impracticable under ordinary circumstances. When caught they must be carefully handled, as they are very vicious, and bite with great severity. In confinement they continue sullen and intractable, so great being their irascibility under these circumstances that when several are boxed together they fight with blind fury to the death. Their food is herbage of all kinds, but especially bulbous roots, great stores of which are conveyed in their capacious pouches into their subterraneous granaries. Notwithstanding their lumpish figure, they are extremely quick in their movements, and always on the alert for danger when they venture to show their nose above ground. So careful are they to make good their retreat, that they seldom venture far from their holes; but actually travel long distances under ground, like moles, breaking the surface now and then, but covering their tracks with little mounds of earth at each aperture they make.

What the gopher carries in his pockets has long been disputed, some averring that the dirt which dots the prairies in little heaps is carried out in these receptacles, others that they are used as ordinary cheek-pouches for the temporary reception of food. The latter is the true state of the case. A gentleman, who has often killed gophers in the act of "crowding up" the earth from their holes, informs us that he never found anything but food in the pouches. They have enormously large fore-parts, and in moving underground, after they have loosened earth ahead, they push it along, propelling themselves mainly by the hind feet, the head quite buried in the mass of soft soil. Coming up as they do from the slanting passage, and reaching the surface, the load of dirt is given a quick, vigorous push, which scatters it with a flint to some little distance. The action may not inaptly be compared with that of a snow-plough before a locomotive, which should, however, to make the comparison perfect, gather snow and dump it ahead at successive stages, instead of furrowing through and leaving it in ridges on either side. Disposing of his load in this manner, the gopher, quick as a flash, backs down into his hole again.

The American gophers pave the way to the Mole-rats, or family SPALACIDÆ, in which fossorial powers and a subterranean mode of life are seen in perfection, with corresponding modification of physical structure. The mole itself is not more completely removed from the light of day, and buried in the bowels of the earth, than are these dumpish stout-bodied rodents, with their short, strong limbs, a short tail or scarcely any, and minute or rudimentary ears and eyes. The back-teeth, from three to six in number on each side in each jaw, are rooted,—a character which principally distinguishes some of the Spalacidæ from the Arvicola-like Siphneinæ of the family Muridæ. All belong to the Old World. There are two sub-families of three genera apiece.

The Bathyerginæ are deep diggers, peculiar in several technical respects, the chief of which is, that here only, among Myomorphs, is there the form of the lower jaw characteristic of the Hystricomorphs,—the angular part of the mandible springing

from the outer side of the body of the bone. The palate is extremely narrow, and the dentition peculiar in several respects. The remarkable *Heliophobius argenteocinerus*, or the Silver-gray Light-dreader of Mozambique, exhibits the largest number of back-teeth of any rodent, having three premolars, besides the usual three molars on each side of each jaw. It otherwise resembles the leading genus, *Georychus*, several species of which inhabit South Africa, *G. capensis* being the best known. In this genus there is but one premolar on each side, above and below. In both of the preceding the incisors are plain; but in *Bathyergus* these teeth are grooved, and of enormous size. There are some half-dozen species of the latter, all of South Africa, among them the Strand Mole-rat (*B. maritimus*). This is about ten inches long, with a tail of two inches; it is of a light grayish color, and provided, like its relatives, with enormous claws on all the digits, excepting the thumb; the ears are rudimentary. It lives in the sandy soil of the sea-side, where its extensive burrows run in every direction.

In the Spalacinae the jaw-bone is normally myomorphic, and the palate is broader than in the foregoing. There are no premolars in this sub-family. Passing by the Indian and Æthiopian species of *Heterocephalus* and *Rhizomys*, which are not quite blind, though the eyes are minute, we may at once notice the extraordinary Mole-rat (*Spalax typhlus*) of Europe and Asia, which furnishes the very extreme of mole-like structure exhibited by the Rodentia. The eyes are rudimentary, and covered with skin, so that the animal is quite blind; there are no external ear-parts; the tail is a mere stub, like a wart; the feet are stout and splayed. The broad, flat head is provided with a line of stiff hairs on each side; the general fur is soft and of a brownish color, marked with white on the head, feet, and under parts. This animal lives in its winding underground galleries, and is seldom seen abroad. Indeed, the economy of species of this whole family would appear to be very similar to that of the Geomyiidae, which we have already noticed at some length.

The MURIDÆ is by far the largest family of the “rats and mice, and such small deer,” numerically prevailing over all the others, alike in its sub-family groups or sections, of which there are no fewer than ten; in the aggregate of its genera; in the great array of species of leading genera, such as *Mus*, *Hesperomys* and *Arvicola*; and



FIG. 49. — Upper, under, and side views of a Murine skull.
(*Sigmodon hispidus*.)

in the profusion of individuals of some species, which fairly swarm in different parts of the world. The family is the most nearly cosmopolitan of any group of its grade among mammals; and so various are its representatives in external characters and habits, as well as in more technical points, that it is not easy to define the fam-

ily as a whole, except by exclusion. The jaw-bone and leg-bones are typically myomorphic. There is a cæcum (as in all rodents excepting the dormice). Excepting one genus (*Sminthus*), there are no premolars in the Muridæ, the back-teeth being thus definitely reduced to three molars on each side, above and below; excepting, again, the genus *Hydromys*, in which there are only two. The molars occur under two leading modi-

fications. In Siphneinæ and Arvicolinæ they are rootless (or only rooted in old age in a few cases), of highly complicated structure, consisting of a number of angular prisms, and in their highest development, as seen in a field-mouse, lemming, or muskrat, exhibit the perfection of rodent dentition, growing perennially like the incisors themselves. In other sub-families the molars are rooted, and, as a rule, simply tubercular, without sharp salient angles and re-entrances. There is a very characteristic shape of the infra-orbital foramen, which is large, pyriform, wide above and running downward, and bounded externally by a broad plate of the maxillary root of the zygoma, the malar or zygomatic bone proper being reduced to a slender splint between the maxillary and the squamosal. Such is the rule, but there are exceptions. The hind feet have five toes, the fore have but four developed

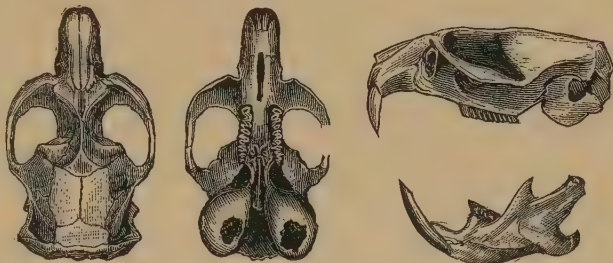


FIG. 50. — Upper, under, and side views of an Arvicoline skull.
(*Arvicola xanthognathus*.)

digits, though the rudimentary thumb may be large enough to bear a nail. Other external characters are too various to be concisely given. Cheek-pouches are developed in some, not in others; their absence is the rule. The size is generally small; the muskrat is the giant of the family, and the house-rat is above the average; some are smaller than the house-mouse. The Muridæ number, collectively, upwards of three hundred species (say one hundred for the genus *Mus* alone), referable to some thirty-five genera and ten sub-families.

The first division which we will consider contains the Muridæ with rootless molars. We must first dispose summarily of two genera, *Siphneus* and *Ellobius*, forming the sub-family Siphneinæ, which naturalists have alternately assigned to the Spalacidae and the Muridæ. They agree with the mole-rats in external characters, having small eyes, rudimentary ears, very short tail, strong claws, and stout cylindric bodies; but in more essential characters of the skull and teeth they are murine, the dentition in all respects being as in Arvicolinæ, next to which the Siphneinæ may undoubtedly be placed. They are confined to the Palæarctic region. The Zokor (*Siphneus aspalax*) is a representative species.

The Arvicolinæ is a large group, the second in extent of the family, only exceeded by the Murinæ themselves in numbers of genera and species, and probably surpassing all quadrupeds in number of individuals which swarm in the sphagnous swamps of the North, some being the most arctic of quadrupeds. They are a circum-polar group, some species indeed being common to both hemispheres; decreasing in abundance of individuals from the arctic regions southward, but multiplying in genera and species in temperate latitudes, and then ceasing in sub-tropical portions of the Northern Hemisphere. These vast multitudes furnish at once the chief subsistence of countless birds and beasts of prey, and one of the most serious obstacles to agriculture; while only a single species, the muskrat, is of any commercial value. One of the lemmings, like some of the hares, turns white in winter. Excepting only the muskrat, which is peculiarly modified for aquatic life, the Arvicolinæ are small creatures, under the size of a house-rat, with chubby, stocky body, short, hairy tail and limbs, small eyes and ears, thick head, blunt muzzle, and copious soft fur. The

jaw-bone, strictly myomorphic, has, nevertheless, a peculiar crookedness of the angular process, different from the lamellar-shape of the same part in Murinæ, and it curves up to the level of the under-teeth. The whole skull is massive, with various angularities; the palate is vaulted; the zygomatic arches are stouter than usual for Muridæ, and do not dip down to the level of the palate. The upper incisors are usually broader across than in the opposite direction; and when, as is commonly the case, the root of the under incisor causes a protuberance of the bone of the jaw, such a projection appears on the inner side, at or near the notch between the condyles and the angular process (compare Murinæ beyond). The molars are rootless (only semi-rooted in one genus), consisting of an aggregation of more or fewer (two or three to eleven) flat-topped prisms; so that each tooth, viewed on its crown, presents a sharply serrate periphery of several salient and re-entrant angles, with intricate tracery of the implicated folds of enamel which encloses variously-shaped islands of dentine. No cheek-pouches are found in this sub-family. Each genus, and even the leading species of each genus, has a peculiar pattern of the molars by which it may be identified. The genera are *Fiber*, *Cuniculus*, *Myodes*, *Synaptomys*, *Arvicola* with several subdivisions, and *Eutamias*, embracing the multitude of animals known as water-rats, field-mice or voles, and lemmings.

The Ondatra, Musquash, or Muskrat (*Fiber zibethicus*) is too well known an inhabitant of North America at large to require detailed description. Its chief peculiarity is the long tail, as scaly as that of a beaver, but narrow and compressed vertically, almost like a knife-blade. It is thoroughly arvicoline in other respects; and, though especially fitted for an aquatic life, is scarcely more addicted to such habits than some species of *Arvicola*, notably the water-rat of Europe (*A. amphibius*). It is much the largest of the family, about a foot in length, the tail six or eight inches; the pelage dark glossy-brown above, more grayish below, with copious soft under-fur, impervious to water. The young are blackish. As in many other aquatic animals, the hind feet are comparatively large and somewhat "clubbed," that is to say, set on obliquely at the ankle-joint, so that they may easily assume positions like those given by a rower to his oars in "feathering." The soles and palms are perfectly naked; the toes of the hind feet are partially webbed. The tail acts as a rudder, being very flexible sideways. The ears are buried in the fur, and the muffle is completely furry, excepting the small nose-pads. The mammae are six in number. The muskrat is so timid and watchful, and its habits are so secretive, that it is not seen so often as one might expect, even in places where its tracks in the muddy banks, and the habitations it constructs, sufficiently attest its presence in large numbers. Sometimes its retreats are simply burrows in the bank, with one or more apertures leading out under the water; at others, it constructs large, domed houses of matted vegetation, which rise above the level of the water, but, like the burrows, have their entrance below. The general plan is then similar to that of a beaver-house; and indeed there is much likeness in the economy of these two creatures. Muskrat skins have a commercial value, and immense numbers are taken, chiefly by trapping.

Lemmings are simply Arctic Arvicolas, modified to endure the rigors of the dismal hyperborean regions, where they swarm in almost incredible numbers, and sometimes perform the most extraordinary and erratic migrations in vast armies, the sudden apparition of which gave rise to the popular myth that they fell from the clouds. Grave scientific treatises have been devoted to this subject. There are two very distinct genera of lemmings. The Collared or Snowy Lemming (*Cuniculus torquatus*)

turns pure white in winter, while the others, of the genus *Myodes*, do not. In summer this curious creature is prettily dappled with chestnut, black, gray, and buff, usually with a dark dorsal line, a light collar, and white tail and feet. In form it is the chubbiest of all, with a dense and copious pelage, furry hands and feet, the hairs sometimes reaching half an inch beyond the claws, a mere pencil of hairs for a tail, and no external ears. Here the molars acquire the maximum known number of prisms, there being on one of the teeth no fewer than eleven sharp, salient, alternating angles, six along the inner border, and five outer ones. The fore claws are extremely large, and have the peculiarity of being at some seasons duplicated, as it were, by an



FIG. 51.—*Myodes lemmus*, one-half natural size.

enormous growth of horny substance along their under surfaces, which is periodically shed and renewed; its use is not known. This lemming inhabits the arctic regions of both hemispheres, especially North America and Greenland. The species of *Myodes*, two or three in number, have no such peculiarity of the claws, and do not change color; they are altogether more like ordinary Arvicolas, though retaining to some extent the stout form, with short members, of *Cuniculus*. They are of livelier and more variegated coloration than is usual in this group, and have decided dental characters of generic value. *M. obensis*, of Arctic Asia and North America, is sometimes of a bright orange-chestnut above and rusty orange below; the short-haired, small-clawed, and dark-colored feet contrasting with the condition of these parts in the collared lemming. The size is about the same,—four to six inches. The North European species is the original “Lemming,” *M. lemmus*. This is the animal so

famous for its migrations. Our historical accounts of the more conspicuous invasions of the Norway hosts date back for a century and a half at least. The cause is not well determined, but the movements are probably connected in some way with irregular oscillations in their myriads, and overcrowding of the lemming population; for when the reproduction is from any cause excessive the surplus must go elsewhere. A tendency to such "tidal waves" of increase, and corresponding movements of a species *en masse*, is seen in various Arvicolinæ, though it probably never reaches such a climax as that attained when the lemming hordes leave their mountain fastnesses for the lowlands. Nothing can stop them; they proceed straight on in their course, urged by some resistless impulse, swimming broad rivers and lakes, and invading towns which may lie in their way, until they come down to the sea. Blindly insensible to danger, running every risk, incessantly preyed upon by foes of every kind to which they are exposed, and peculiarly subject to disease at such times, countless thousands necessarily perish; the movement thus proving a necessary check upon their excessive multiplication, and tending to readjust a disturbed balance of animal life.

A remarkable little animal, *Synaptomys cooperi*, has only lately been discovered to inhabit various portions of North America, from the valley of the Ohio to Alaska. In outward form and in habits, so far as these are known, it resembles an ordinary field-mouse; but on examination the dentition is found to be that of a *Myodes*, with the peculiarity of grooved incisors, unique in the sub-family Arvicolinæ.

The species of *Arvicola* itself are numerous and fall in several sections of the genus, chiefly according to the details of construction of the prismatic molars. These constitute the voles of Europe, the field-mice or meadow-mice of North America. They abound nearly throughout these countries, and are everywhere pests to the farmer. Some, like *A. amphibius*, the common Water-Vole or Water-Rat of Europe, are decidedly aquatic; and, in general, the Arvicolas prefer low, moist meadow-land in the vicinity of streams, which affords conditions not unlike those of the peat bogs and sphagnum morasses, in which the more northerly kinds swarm. Some, however, are found in mountainous localities, and some on the high and dry prairies. They are small animals, rarely over five inches in length, readily distinguished from mice proper by their short limbs and tail, thick form, blunt muzzle, low ears mostly buried in the fur, and dark, unvaried colors. They bring forth in underground burrows, and are very prolific. Their movements, though quick enough, have not the ease and freedom which marks those of ordinary mice. We can barely mention some of the leading species. In Europe, besides *A. amphibius*, already mentioned, there are the Field-Vole (*A. agrestis*), with its southern relative (*A. arvalis*), and an Alpine species (*A. nivalis*), which lives up to the limit of perpetual snow in the Alps and Pyrenees. The Root-Vole (*A. œconomus*) is a large and abundant Asiatic species. The commonest North American one is the Meadow-Mouse (*A. riparius*), which, in some of its endless varieties, inhabits the greater part of the continent. Another is the very large chestnut-cheeked species (*A. xanthognathus*), confined to regions north of the United States. A very common form in the Mississippi valley and westward is a medium sized, rough-haired, grayish species called *A. austerus*. A smoother and brighter colored one is the Pine-Mouse (*A. pinetorum*). Each of the three last-named represents a different sub-genus; and the latter is notable as the most southern expression of the genus, having a Mexican representative, *A. quasiater*.

The Red-backed Mouse of America, occurring from the Northern States to the Arctic Ocean, and the Bank-Vole of Europe, are varieties of one circumpolar species

which constitutes the genus *Evotomys*. This is distinguished from all other Arvicolas by having semi-rooted molars, and some cranial peculiarities, together with larger ears than usual, these distinctly over-topping the fur. The coloration is livelier than ordinary, the upper parts being quite reddish. The boreal stock-form is *E. rutilus*, which southward passes into the variety *gapperi* in North America, and variety *glareola* in Europe. The latter is said to be one of the most prolific of quadrupeds, producing four to eight young three or four times a year. The species of this genus are more like ordinary mice than are any other Arvicolas, thus furnishing a link between the present and the next sub-family, as well as between the rootless and rooted-molar sections of the whole family, the latter of which we will now consider.

Coming now to the central and by far the largest sub-family, the Murinæ proper, we find it as difficult to frame a definition of the group, with relation to the other sub-families, as it is to concisely distinguish the Muridæ from the other families of the great myomorphic alliance. But the house-rat and house-mouse typify and exemplify the whole; all the variations from these well-known standards, though multifarious, being of scarcely more than generic value. In a group of such great extent, it is of advantage to establish divisions if possible, and one line at least may be drawn, almost unexceptionally, separating all the Murinæ of the Old World from all those of the New. In the former series, the dentition is stronger than it is in the latter; the molars being thicker across, and their unworn crowns presenting three series of tubercles; in the latter, there are but two such series, and the molars are by so much narrower and weaker. When the tubercles wear down, the enamel ridges and dentine islands correspondingly differ in the two series, and the American Murinæ have been called *Sigmodontes* from the tracery which results in some cases. The only known exception to this rule is furnished by the Madagascar genus, *Nesomys*, the teeth of which are described as like those of the American *Hesperomys*. None of the Old World Murinæ appear to develop cheek-pouches, which are of common occurrence in *Hesperomys*, etc. We accordingly draw a line which separates the two sets of genera, both by physical characters and by geographical distribution. The organization of the Old World forms would appear to be superior to that of the New; for whenever the two come in contact the latter yield and retire before their imported rivals.

The genus *Mus* itself, with its long array of a hundred species, absorbs the majority of the series of Old World *Mures*, with tri-tuberculate molars, including at least one-third of the entire family Muridæ. If the reader will strike a balance of size between the house-rat and house-mouse, and allow some little margin for variation in form, the whole genus will be before him as well as the most elaborate technical detail could present it. The colors of the old gray rat, and the little brown mouse—the latter having passed into a descriptive term of “mouse-color”—are, however, far from expressing the range of color in *Mus*,—the tints being often bright and lively, and sometimes much variegated; the snowy breast and paws of a *Hesperomys*, for example, being also repeated in some cases. In a few species, the coat is very hispid, or even prickly. The long, slim, rounded tail, with its whorls of scales,—that which has given a name to a familiar instrument, the “rat-tail file,”—is a conspicuous and very constant character. In the clambering of the species over uneven objects, it is of great assistance to have this “dragging anchor;” while in some species the same useful member becomes prehensile to a degree, thus capable of being neatly twisted about the slender swaying stems of plants.

Some species of this genus are parasitic upon man, and have followed his tracks all

over the world. The nativity of the brown House-rat, also, but very improperly, called the Norway rat (*Mus decumanus*), is unknown, but probably Asiatic, as the species



FIG. 52. — *Mus decumanus*, brown house-rat, one-half natural size.

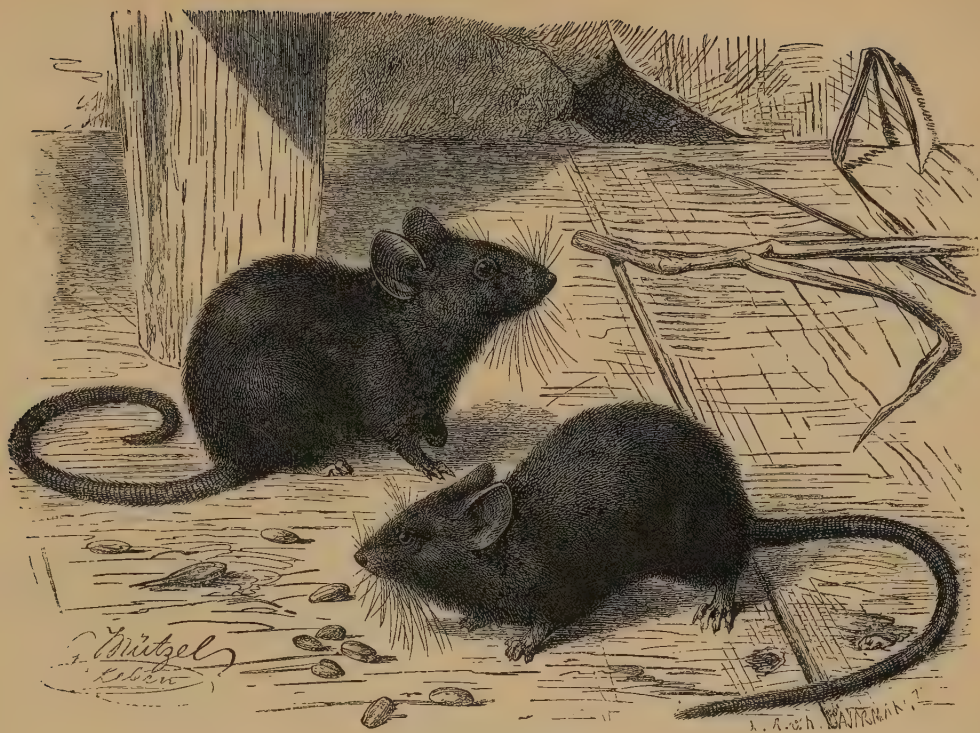
has been known from Eastern countries for a long period. The date of its appearance in Europe has been fixed by one author at 1727; it had overrun that country by the middle of the same century, and it has at length been transported in ships all over the world. Its fecundity, its ferocity, and indomitable persistency, its ubiquity, voracity, and low cunning, to-

gether with a tough and elastic physique, which readily adapts itself to circumstances, assure its foothold everywhere. In America it drives away not only the



FIG. 53. — *Mus rattus*, black rat, two-thirds natural size.

native Sigmodontes, but also those weaker species of its own genus, as the Black (*M. rattus*) and White-bellied Rat (*M. alexandrinus*), with which it comes into competition. Landing upon small islands from shipwrecks, and pressed for food, it has been



Mus musculus, mouse.



Mus decumanus, brown rat.

known to exterminate other animals in a few years. It is probably the most carnivorous, or rather omnivorous, of its tribe, and to some extent acts as man's scavenger in the sewers and abattoirs of cities; but there seems to be no other useful trait to offset its pestiferous qualities. The ferocity of a rat in a corner is proverbial; a swarm of the animals, frenzied with hunger, have been known to attack and even kill a man; while there are only too many sad authentic stories of neglected babies being destroyed and devoured by these insatiable creatures.

The black and the white-bellied rats, above mentioned, appear to be the only additional Old World species which have secured foothold in the New, excepting, of course,

the House-Mouse (*M. musculus*). There is only one capacity of this little creature to which I need allude, and that is its singing,—a musical faculty which all have heard of, but probably few have heard, leaving many to doubt. A mouse which I once had presented to me was a great singer. Placing the cage in my bedroom, I turned off the gas and retired, to give it every encouragement to proceed with the expected programme in quiet



FIG. 54. — *Mus musculus*, common mouse, natural size.

and darkness, but with grave doubts that it would favor me with a song. In a few moments, however, the little musician piped up, and sang very prettily,—it was not squeaking, but singing, musically and rhythmically, in a high key, with a thin and wiry, but not displeasing quality,—something like a weak-voiced canary-bird. Listening for some time till I grew sleepy, I placed this eccentric *prima donna* in an adjoining room, at least twenty feet from my bed, the door open between; but even at that distance the singing was loud enough to disturb me, and I had to carry the little creature down stairs before I could get to sleep.

Among the best-known European species of the genus are the pretty Wood-Mouse (*M. sylvaticus*), which resembles the American *Hesperomys*, and the tiny little Harvest-Mouse (*M. minutus*), three inches long. Necessarily passing by numberless others we should like to notice, we can only mention the remaining Old World genera. *Pelomys* is distinguished by its grooved incisors and short tail; *P. fallax* inhabits Mozambique; Africa furnishes a genus (*Acanthomys*) in which the fur is mixed with spines. Australia has a peculiar form, *Echinothrix*, with a pelage of similar character. This exceptional continent is also supplied with rats peculiar to itself of the remarkable genus *Haplotis*, of which there are a dozen different species. These have the hind limbs lengthened, somewhat jerboa-like; the ears large and tapering, the tail long and hairy, tufted at the end. *H. albipes* is the best-known species, with white feet and belly, dark brown above, and about the size of a house-rat. Madagascar was long supposed to possess no rodents whatever; but two genera have been lately ascertained to inhabit that island, so remarkable in its faunal features; these are *Brachytarsomys* and *Nesomys*, the latter notably peculiar in its dentition, as stated above.

The large and beautiful genus *Hesperomys*, with its several sub-divisions and

numerous species, extending almost throughout Continental America, illustrates the New World Sigmodontes, with bi-tuberculate molars, perfectly; and the common White-footed Mouse (*H. leucopus*)—also called Deer-Mouse, Wood-Mouse, and sometimes Field-Mouse—is a good illustration of the genus. It occurs under several local races, nearly throughout North America. It is a pretty little creature, of some shade of fawn or buff color, obscured with darker along the back; the feet from wrist and ankle, and the whole under-parts, snowy white; the tail close-haired throughout, two-colored to correspond with the darker upper and white under-parts; the young ones are slate-grey. Its length is three or four inches, the tail averaging but little less. The eyes are full, the ears high and rounded, the limbs delicately fashioned, the whiskers long. The form is lithe, and the movements are agile and graceful. Like other species of this genus, it has small cheek-pouches, the existence of which was long



FIG. 55. — *Hesperomys leucopus*, white-footed mouse.

unsuspected. It inhabits all kinds of places, and in the West some varieties take up their residence with man as familiarly as house-mice. There are numerous local races or sub-species of *H. leucopus*. The Golden-Mouse (*Hesperomys aureolus*) is still handsomer, with more vivid coloration, being golden-cinnamon above and yellowish-white below. This is confined to the Central and Southern States. *H. michiganensis* is a small dark-colored species, inhabiting portions of the Mississippi valley. *H. californicus* is a large species, with nearly naked tail and ears. Other species of this immediate group occur in Mexico and Central America. The foregoing belong to a sub-generic group called *Vesperimus*. In South America there are numerous species, not so well worked up as might be desired, but all apparently sub-genericallly distinct from those of North America. The last-named half of the continent also furnishes two isolated species, forming, respectively, the sub-genera *Onychomys* and *Oryzomys*. The former is the Missouri Mole-Mouse (*H. leucogaster*), shaped something like an *Arvicola*, with its short tail, less than half as long as the body, and enlarged fore feet. The system of coloration is, however, as in *Hesperomys* proper, with snowy feet and under-parts. The latter is the Rice-field Mouse (*H. oryzomys*)



Mus minutus, harvest mouse.

of the southerly United States, especially along the Atlantic sea-board. This exceeds all the other North American *Hesperomys* in size, being four or five inches long, the tail about the same, or rather more, and very scant-haired; the pelage is a dark, grizzly rat-color, and not distinctly bicolor; so that, of all our native species, this one most resembles superficially some Old World species of *Mus*. The pelage is harsh, like that of *Sigmodon hispidus*. It should also be specially noted that this animal, or a related species of the sub-genus *Oryzomys*, occurs in Jamaica, furnishing the only instance of an American murine in the West Indies.

Related to the white-foot mice proper, but quite distinct, are the curious little Harvest-mice of the genus *Ochetodon*. One would think, on first viewing one of these delicate and diminutive creatures, that it was a young house-mouse, so similar do they appear. But the harvest-mice have all the essential characters of American Sigmodonts, with the peculiarity that the upper front teeth are deeply grooved—a feature only elsewhere found, among American Muridæ, in the South American genus *Reithrodon*, and in the Arvicoline *Synaptomys*, above noted. These tiny creatures are among the very least of American quadrupeds, and appear to play the part in this country of the European *Mus minutus*. *M. humilis*, of the Southern United States, is only two inches, or a trifle over, in length, the tail rather less; it is colored like a house-mouse, but has a wash of tawny or fulvous along the flanks, and the under-parts lighter. *O. longicauda* of California is similar, but longer tailed, as in *O. mexicanus*. The genus extends to Guatemala at least.

These little mice were originally referred to the genus *Reithrodon*, on account of the teeth, but very wrongly so. The species of *Reithrodon* are two or three South American ones, different in almost every particular; they are *R. cuniculoides* and *R. chinchilloides*, so named from their respective resemblance to a rabbit and a chinchilla. They both inhabit Patagonia.

The genus *Sigmodon*, giving name to the whole series of American murines, is based upon the well-known Cotton-rat of the Southern States (*S. hispidus*). It is a stout species, some five inches long, the tail an inch or so shorter; of coarse, harsh pelage, intimately grizzled with blackish and yellowish-gray above, grayish-white below, with the tail indistinctly bicolor, and the soles of the feet black. It resembles the rice-field mouse not distant, and both are of a non-committal aspect, suggesting a half-grown house-rat. It extends southwards to Guatemala; chiefly coastwise.

The most hasty survey of the Sigmodont Murinæ would be inexcusably incomplete without special mention of the large, handsome species of the genus *Neotoma*—the wood-rats and bush-rats of North and Middle America, sometimes exceeding the largest house-rat in dimensions. The best-known of these is the Florida Wood-rat (*N. floridana*), which inhabits most of the United States, but especially southern portions. The fur is soft and lustrous, pure white below and on the feet, yellowish-brown above, with a darker dorsal area, brighter on the flanks; in the young the colors are slaty-gray and white. This animal is upward of nine inches long, the tail six or more, close-haired throughout, and distinctly marked to correspond with the body-colors. The system



FIG. 56. — *Ochetodon mexicanus*, natural size.

of coloration is thus that of the white-footed mouse, and the form is much the same. *N. fuscipes* is a distinct species, of California, with the feet partly dusky, and a longer blackish tail. *N. ferruginea* of Mexico and Central America is similar, but smaller



FIG. 57. — *Sigmodon hispidus*, cotton-rat, reduced.

and much more richly colored, being of a warm rusty-red. In all the foregoing the tail is close-haired; in the remarkable *N. cinerea* of the Rocky Mountains this member is bushy, almost like a squirrel's tail. The hairs tend to flatten out, and with this distichous arrangement sometimes measure three inches across, though usually less.



FIG. 58. — *Neotoma floridana*, Florida wood-rat, reduced.

These wood-rats are the animals which build houses in the shape of great heaps of brushwood and other vegetation, several bushels being sometimes heaped up. In some cases great globular nests of miscellaneous trash are built in bushes or trees. The white-footed mice sometimes find the commodious premises of their more distinguished

cousins to be eligible dwelling-places, and make themselves uninvited, but probably not unwelcome, guests. The flesh is white, clean, and well-flavored, superior for the table to rabbit or squirrel, and is an important item in the bill of fare of Indians in the Western Territories. Like magpies, the wood-rats have a very bad reputation for thieving; any



FIG. 59. — *Neotoma ferruginea*, Mexican wood-rat, reduced.

old squatter or miner has his stories to tell of the way they steal and drag into their holes everything they can lay hands on.

We have seen cheek-pouches in some of the American Murinæ; and finishing this sub-family, at length we pass to the Cricetinae, or Hamsters, in which such organs are highly developed — as is fortunate, perhaps, for there is little else to distinguish them, collectively, from Murinæ. The hamsters are all Old World, occurring only in the Palæarctic and Ethiopian regions. The European species (*Cricetus frumentarius*), which is also extensively dispersed in Asia, is a very well-known animal, often kept in confinement, about ten inches long, the hairy tail about two and a half inches. The color is usually yellowish-brown, with black, reddish, and yellowish markings on the head; the under-parts and most of the limbs black, but the feet white. As implied in the specific name, this animal is a hoarder of grain and numberless other articles of diet, which it takes good care to store in its capacious underground galleries before it “turns in” for the winter. It is described as irritable and pugnacious, standing up courageously for itself before its enemies at whatever odds. It revives from its long hibernation early in the spring, pairs betimes, and produces, in May, and again during the summer, a very numerous



FIG. 60. — *Cricetus frumentarius*, hamster.

progeny, which are almost as precocious as guinea-pigs, having cut their teeth when born, and thereafter soon getting their eyes open, they know enough to shift for themselves in a couple of weeks. There are other species of *Cricetus* in Asia. The African hamsters belong to different genera. *Saccostomus lapidarius* has smaller grain-sacks, weaker feet and claws, and some cranial peculiarities. *Cricetomys gambianus* is distinguished by the grooved incisors, and long, scaly tail.

Africa also harbors three notable genera of Muridæ, which have been combined in a sub-family, Dendromyinae. In *Dendromys mesomelas* the incisors are grooved; the three middle digits of each foot are much longer than the first and fifth; the general form is slender, and the scant-haired tail is long. This little animal, which is arboreal in habits, is of a grayish color, with a black stripe down the back. *Steatomys pratensis*, of Mozambique, is a similar creature, but stouter in form, with a short, thickly-haired tail. In *Lophuromys ater*, of the same region, the pelage develops fine flattened bristles, and the incisors are not grooved.

Eastern regions also furnish their quota of isolated and peculiar forms. The *Phlæomys cumingi* of the Philippines, and the Indian *Nesokia griffithi* compose the sub-family Phlæomyinae.

Again, the Malabar coast yields us *Platacanthomys lasiurus*, sole member of a sub-family, Platacanthomyinae, in which, as in the Phlæomyinae, the molars are divided into transverse laminae. The Malabar animal somewhat resembles a dormouse; the tail is densely hairy, and the pelage is mixed with flattened spines.

The laminar condition of the teeth just mentioned is substantially repeated in the large group of the Gerbilles, widely distributed in the Old World, and constituting a sub-family, Gerbillinae. These are remarkable among Muridæ, and only approached by the species of *Hapalotis*, in the great elongation of the hind limbs, which confers jerboa-like saltatorial powers. The gerbilles are plump animals, with long hairy tails, broad heads, and sharp noses. They are chiefly African, but also inhabit India and Southeastern Europe, living in underground burrows, in which, like hamsters, they lay up great stores of provisions.

It only remains, to conclude the Muridæ, to say a word respecting two remarkable genera which do not show the dental formula normal to the family. The species of *Hydromys*, composing the sub-family Hydromyinae, are Water-mice of Australia, in which one molar is missing above and below, leaving $\frac{4}{4}$, — a character unique not only in this family, but in the order Rodentia. The hind feet appear to be modified to serve as paddles by partial webbing, like those of a muskrat. Several species are described, as *H. chrysogaster*, *H. leucogaster*, and *H. fuliginosus*.

The Smithinae, consisting of the *Sminthus vagus* alone, present the opposite anomaly of redundancy, having a premolar on each side, above and below, the formula for the grinders being therefore $\frac{5}{5}$. This character prepares us to find again, in the family Myoxidae, which is soon to follow, that premolar which we have not hitherto seen since we left the mole-rats (Spalacida). *Smithus* is a small rodent of wide distribution in Europe and Asia.

The family LOPHIOMYIDÆ, or Skull-caps, is based upon a single species, *Lophiomys imhausi*, an extraordinary animal, described in 1867 by M. A. Milne-Edwards, from whose monograph we condense a brief account. For a long time only one individual, brought alive to Paris from some uncertain country, was known; but latterly three additional specimens have come to light, and its *patria* ascertained to be the Ethiopian

region, particularly Abyssinia. The creature somewhat resembles a skunk in its black-and-white striped coloration, and is four-handed like an opossum. It is rather larger than a guinea-pig, with a stout form, low on the legs, and a bushy tail nearly as long as the body; the pelage is very long, forming a sort of crest or mane all along the back, which can be elevated or depressed at will, the equally long hairs of the sides of the body falling down, leaving a furrow between themselves and those of the mane. In this groove are spongy hairs of a peculiar microscopic structure, different from those of any other quadruped. The feet have small, sharp claws. The paws have five toes, but the thumb is very short; the inner toe of the hind foot, on the contrary, is well developed, freely mobile, and opposable to the others, as in opossums and monkeys generally. It is rarely that we are permitted to see in a single species of quadruped characters not elsewhere found in the whole class Mammalia; but to find the parallel of the cranial peculiarities of the creature we have to look to reptiles; for the skull, though murine in most respects, is surmounted by a dome of articulated, granular, bony plates,—singular structures which may be regarded as an enormous exaggeration of the temporal crests, these being so expanded laterally as to bend down and join the similarly modified zygomatic arches, thus roofing in the temporal fossæ. The first bone of the spinal column, the atlas, is granular like the cranial dome. The dentition is murine, the molars being $\frac{6}{6}$ as usual, rooted, and resembling those of *Cricetus*. The clavicles are imperfect. The cæcum is small. The peculiar cranial structure of the paca (*Cælogenys paca*—see p. 84—) may be noted in this connection, though the character of the anomaly is different in the two cases.

The family MYOXIDÆ contains the dormice,—elegant little creatures, which might be called squirrel-mice, so near are they in real affinity, as well as in superficial aspect and in habits, to the squirrels. Their structure, however, is substantially myomorphic, and they differ, not only from both mice and squirrels, but from all other rodents as well, in having no cæcum,—an appendage which, but for this exception, one might have considered indispensable for the convenience of the gnawers. There are also some peculiarities in the stomach, which is simple in most genera, but complicated in *Muscardinus*. There is a premolar above and below, the grinders being therefore $\frac{3}{3}$; the molars are all rooted, and have transverse folds of enamel. The dormice are confined to the Old World, and are widely distributed in Europe and Asia, with some outliers in Africa. Their form is neat and gracile; they have full eyes, high ears, well-shapen limbs, and a long hairy tail, which in *Myoxus* proper is bushy and distichous throughout; in *Muscardinus* is bushy but cylindrical throughout; in *Eliomys* is tufted and flattened at the end, while in *Grophurus* it is shorter, and like a lead-pencil, as the name shows. The last-named is the African outlier. There are about a dozen species in all of the four genera mentioned.

The Common Dormouse (*Myoxus avellanarius*) is a very pretty form, with a squirrel-like tail, which sits up on end and handles its hazel or beech-nuts with all the air of a squirrel, and displays no less agility in skipping about the shrubbery and tangle it inhabits and forages in—sometimes hanging head downwards by the hind feet, again crawling adroitly along the underside of a horizontal branchlet. It is chiefly nocturnal, and at the approach of cold weather, when it has laid on a good coat of fat, it crawls into a snug nest, constructed for the purpose, curls up in a ball, wraps itself up in its tail, and goes to sleep. From this lethargy, however, it may awaken at intervals during the winter, if the weather be mild. The family of little dormice usually numbers three

or four; and either the parent breeds more than once a year, or else is very irregular in her periods. The species is a wide-ranging one in Europe, in southern portions of which continent, where it is more abundant than at the north, it occurs in company with the two other larger European species, the Loir (*M. glis*) and the Lerot (*E. nitela*), both about six inches long, the dormouse being only about three.



FIG. 61. — *Myoxus glis*, loir, and *Eliomys nitela*, lerot, natural size.

The fossils known to be myomorphic (aside from those mentioned under Theriodomyidæ) are numerous, but those which have been well-determined are, for the most part, closely related to living forms. They carry the history of this alliance back to the eocene, and among them are represented several of the families we have discussed, especially the Muridæ and Myoxidæ. Passing by some which are insufficiently known, those considered by Alston as probably referable to the Muridæ are *Cricetodon*, *Eumys*, *Mysops*, and *Heliscomys*.

Though neither so extensive nor so multifarious as the other great rodent alliances, the SCIUROMORPHA are a diversified series in form and function, ranging from the large, heavy, aquatic beaver, or the terrestrial and fossorial marmots, on the one hand, to the small and agile arboreal squirrels, some of which almost fly through the air by the singular means with which they alone of rodents are provided. The prime peculiarity of this series is the distinctness of the leg-bones from each other, the fibula being almost invariably free from the tibia, and not, as in the Leporine series, articulated with the heel-bone. The collar-bones are perfect. The angular part of the jaw-bone is substantially as in the Murine series, springing from the under border of the bone, not from its outer side, as in the Hystricines. Premolar teeth are always present; there may be one on each side of each jaw, or two above only. In the former case (1°), the single premolar on each side, above and below, is large, and resembles the other grinders; in the latter (2°), the anterior upper premolar is always

small, sometimes minute or early deciduous. The molars may be either rooted or rootless. There are several cranial characters, among them the great part the malar-bone takes in forming the zygomatic arches. Post-orbital processes are present or absent; they are present in *Sciuridæ*, and the great numerical preponderance of this family makes their absence in other families seem exceptional. The muffle is substantially as in *Murines*, naked and cleft, with comma-shaped nostrils. Excepting the beaver, the tail is hairy, often bushy, and either cylindrical or distichous; it is long in most genera. The group is nearly cosmopolitan. There are six families, two of them, however, being extinct. So far as the living forms are concerned, the *Sciurine* series connects with the *Murine* by the relation between the true squirrels and the squirrel-like dormice; but we shall find it convenient to first consider the fossil families related to the beavers, and then pass from the latter through the sewellel to the marmot squirrels, and thence through the tree and flying squirrels to the similarly flying *Anomalures*.

The first of these families of fossils is the *CASTOROIDIDÆ*. "The so-called 'Fossil Beaver,' of North America," says Mr. Allen, the latest monographer of the extraordinary animal, "was of about the size of a full-grown common Black Bear (*Ursus americanus*), hence somewhat exceeding in size the *Capybara*, the largest of existing Rodents. A cast of a skull now before me has a length of over twelve inches." This Titan of the rodents is generally thought to have the affinity to the beaver that its name implies; but great differences between the two types were early pointed out by Dr. Wyman, and further elaborated by Mr. Allen, who exhibits the singular combination of characters which ally the animal on the one hand to the beaver, and on the other to the *Chinchillidæ*, but at the same time distinguish it from either. The likeness to *Castor* is mainly in the generic configuration of the skull, many details of which are carried out as in *Chinchilla*. A separate family has therefore to be made to accommodate the single genus and species, *Castoroides ohioensis*. Mr. Allen thinks, however, that some imperfectly known remains from the bone caves of Anguilla Island, called *Amblyrhiza* and *Loxomylus*, and supposed to be chinchilline, may also prove to belong here. *Castoroides* was discovered at Nashport, Muskingum County, Ohio, and first described in 1837; various specimens have since been found in different localities from New York to Texas, and from Michigan to South Carolina.

A remarkable rodent from the miocene of North America combines the dentition of a typical squirrel with cranial characters like those of a beaver, and especially of a miocene beaver, such as *Steneofiber*; but differs from both in the large infra-orbital foramen, and from *Castor* in several respects. Upon these considerations Mr. Alston forms the family *ISCHYROMYIDÆ* for the reception of the genus *Ischyromys*.

While we are occupied with these extinct *Sciuromorphs*, we may allude to several other fossil genera more or less nearly related to the living beaver which we shall presently notice. Well-determined genera, such as *Diobroticus* (pliocene) and *Steneofiber* (miocene), are really extinct beavers, falling as far as they are known within the limits of the family *Castoridæ*, as framed for the beaver. Others, more uncertain, but belonging here or hereabouts, are such as *Eucastor*, *Palæocastor*, *Chalicomys*, *Palæomys*, and *Trogontherium*. Such considerations as these would lead us to suppose that the beaver of to-day is the surviving link in a chain of forms, or line of development, which, if traced back to the point where the *Sciurine* and the *Hystricine* series

began to diverge, would be found connected with some such form as *Castoroides*, which combines characters of these two great groups. The living genus *Haplodon*, probably now approaching extinction, is certainly a very perfect connecting link between the beaver-like animals and the typical *Sciuridæ*.

The beaver, for which, as has just been said, the family *CASTORIDÆ* was formed, is one of the largest and heaviest of existing rodents, and of very sturdy organization, especially in the hinder parts of the body. It sometimes attains a weight of fifty or sixty pounds, though generally only about forty-five. The tail is remarkable, both in its shape and in its naked scaly covering, being very broad and heavy, flattened and spoon-shaped. The head and body of the beaver are about two feet long, the tail about ten inches. The hind feet are large and webbed, and the second digit usually bears a curious "dew-claw," appearing as if doubled; the fore feet are comparatively small and neat, and there is a supplementary ossicle among the wrist-bones. The low rounded ears are nearly hidden in the fur. It is hardly necessary to describe this the best known of all commercial furs,—one so long and so universally employed that the name of "beaver" is attached to various fine fabrics which have nothing whatever to do with the animal itself. Such pelage exhibits the perfection of a water-proof covering for a thoroughly aquatic creature, with its dense and copious pile of soft grayish under-fur, overlaid with polished and glistening chestnut-brown hairs.

More technical characters must also be noticed. The skull is *sciurine*, but more massive than is usual in *Sciuridæ*, and devoid of the post-orbital processes so conspicuous in the squirrels. The infra-orbital foramen is small, and placed far down in the root of the zygoma; the middle line of the skull rises in a sagittal crest. The back teeth are $\frac{3}{3}$, with one premolar above and below on each side; they are of sub-equal size throughout, complicated with re-entering enamel-folds, and semi-rooted; that is to say, the pulp-cavities long remain open, so that the teeth continue to grow as they wear, till finally the roots close up and the growth ceases. The stomach has a glandular appendage; and the termination of the digestive canals receives that of the uro-genital organs in a common cloaca. The Weberian vesicles (or "male uterus") are highly developed. There are very large salivary glands, forming a sort of collar in the throat, like a goitre; while at the other end of the body are developed those glandular pouches which secrete the remarkable substance known in commerce as *castoreum*, and highly esteemed from the most remote times as an article of medicinal virtue. Its use nowadays is chiefly the more practical one of rubbing on beaver traps to attract the animal itself by the scent, and efface the trace of human contact with the instrument. The "scent bags" are among the number of accessory sexual structures with which the beaver is remarkably well provided.

The beaver's family-relations having all died out, the animal now stands alone as the *Castor fiber* of naturalists. The question whether there is more than one species has long been argued. The truth would appear to be that there are some appreciable peculiarities by which the American may usually be distinguished from the European animal. In *C. fiber* proper the forehead, measured on the skull between the eye-sockets, is generally as broad as, or broader than, long, the nasal bones extending backwards beyond the posterior border of the ante-orbital processes; and the auditory bulbs are comparatively forward in position, the basilar cavity being proportionally deep and large. In the American sub-species, *C. fiber canadensis*, the opposite details of cranial

structure prevail. There are no positive outward differences, though the American is, on the average, a larger and "better" animal.

The range of the beaver has extended over nearly all of the Northern Hemisphere, in wooded country at least. But the incessant persecution which it has suffered for the sake of its robe and scent-bags has exterminated it from extensive areas in both hemispheres. In the British Islands it has long been extinct, though there is historical evidence of its former presence; and it has disappeared from much of Southern and



FIG. 62. — *Castor fiber*, beaver, one-tenth natural size.

Western Europe. In America it formerly extended across the continent, and from Mexico northward to the limit of trees. It is almost exterminated in the United States east of the Mississippi — though we have lately heard of a considerable colony in Virginia, and there are remnants elsewhere, as in Maine. In wooded regions in the West, notably the Rocky Mountains, it is still abundant; and within a very few years a writer has traced it at various points from the British nearly to the Mexican border, along the upper Missouri river, about the headwaters of the Platte in Colorado, and the Rio Verde in Arizona.

Fitted, as it is, for a thoroughly aquatic life, and enabled in this way to successfully elude enemies, excepting man, the beaver, nevertheless, has need to exercise all its wits for self-preservation. Doubtless these have been sharpened by necessity, and the animal has become a model of instinctive sagacity, besides developing many interesting traits which flow from the organization of society and a community of labor and interest. Its industry has even given rise to a proverb, "working like a beaver;" and the extent of its operations, in felling trees, damming streams, and building houses, is not easily overrated. But numberless writers upon this fertile and suggestive theme have been too easily betrayed into fanciful exaggeration of the facts, making the beaver a marvel of reflective, purposive, and co-operative intelligence — an imaginary picture which an appeal to nature does not justify. It is repeatedly stated, for example, that beavers only cut down trees which they can use in building their dams, and that they can so gnaw them as to make them fall exactly where they wished them to lie. During a voyage once made by the writer, for about a thousand miles in an open boat, down the Missouri River — from Benton to Bismarck — beavers were found to be very abundant in the upper portions of this course. They were constantly seen swimming in the water; the splash of their tails as they dived from the surface was one of the sounds that most frequently broke the stillness of the night-camp; in some districts the "slides," or paths made in going up and down the soft loamy banks of the river, were passed hourly; cut sticks were floating everywhere, or strewn along the water's edge, or lodged in masses. But I noticed trees in process of being felled which could not have fallen in any available position, nor, indeed, into the water at all. In one respect, however, the beaver's powers can scarcely be exaggerated, and this is the size of the trees they sometimes fell. I measured a giant poplar, which was about half cut through just above the base, and found it a trifle over nine feet in circumference at the point of attack. In such large cuttings as these, the way in which the animals use their teeth is very clearly shown. The wood is gnawed in parallel furrows across the grain, these furrows being two or three inches apart; then the chip between them is evidently bitten or wrenched out; for in the furrows the marks of the teeth are plain, while between the gouges only the torn fibre of the wood is seen. The result is exactly that accomplished by an axeman in knocking out a chip by a cut above and below it. But the appearance of the stump left by the beaver is very different; the tree having been gnawed into all around its circumference, an hour-glass shape results, with contracting centre, till the tree falls to whatever side it inclines, and the stump, as well as the cut end of the trunk, is conical. A woodsman makes a tree fall to suit himself, by cutting from opposite sides, not all around. No beaver could learn this trick. What the beaver has found out is that by biting a tree long enough and hard enough he can bring the twigs which he wants to eat down within reach. So he knows enough to fell a tree, but does not know why or how it falls. Much tree-felling is done by beavers, without any reference to dam-building, to secure the twigs and smaller branches for food, and the latter for house-building. Many dams are also built of small stuff, herbage, mud, etc., without any logs of wood. Beavers also live, like muskrats or otters, largely in holes in the banks.

A relic of the past survives over a small area on the west coast of North America, in Washington and Oregon Territories, and a portion of California. This is the "Showt'l" or "Sewellel" of the aborigines, who entertain some curious speculations concerning the relations of the creature to the architect of the universe; known to

more prosaic hunters and trappers as the "Boomer" or "Mountain Beaver." *Haplodon rufus* is of about the size and general appearance of the muskrat, but has almost no tail, this member only appearing as a pencil of hairs about an inch and a half long; the length of the head and body is about twelve inches. The form is very stout; the head is broad and flat, with a blunt muzzle, small beady eyes, moderate ears, and very long whiskers; the limbs are short; there is no appreciable neck. The color is brownish, lighter and grayer below. Such an animal, like a degenerate beaver stranded in the mountains away from water, lives in colonies, in burrows underground, upon various vegetable substances.

Its technical characters show it to be related to the beaver, yet to be almost as much of a marmot; also that it has peculiarities of its own sufficient to found a family, HAPLODONTIDÆ. The feet are both five-toed; the hinder are neither enlarged nor webbed. Enormous salivary glands encircle the neck with a glandular collar.

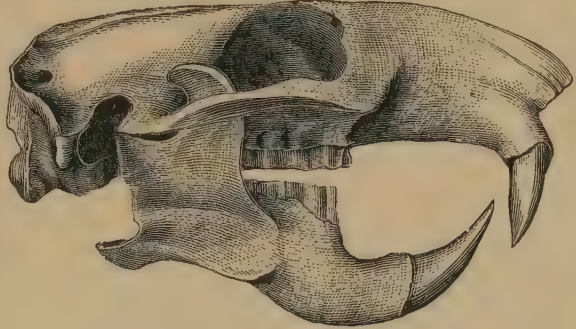


FIG. 63.—Side view of skull of *Haplodon*.



FIG. 64.—Upper view of skull of *Haplodon*.

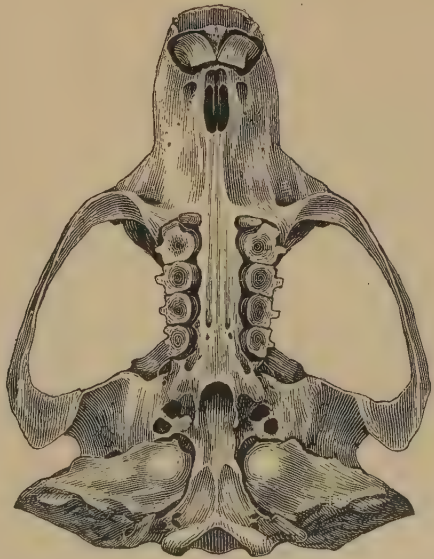


FIG. 65.—Skull of *Haplodon* from beneath.

The outlets of the digestive and uro-genital organs are separate; associate glandular structures are few and simple; the testes are abdominal; there is a forked penis-bone. The cæcum is voluminous, as long as the body; the intestines are about eleven times as long. The skull is sciurine, but lacks any trace of post-orbital processes; it is remarkably pinched between the orbits, elsewhere massive, greatly flattened, and very broad behind, where the zygomas flare widely apart. Aside from the matter of the post-orbital

processes, the general configuration of the skull is as much like that of a marmot as of a beaver. The clavicles are perfect; the tibia and fibula distinct, though closely apposed. The dentition is numerically as in Sciuridæ (*pm.* $\frac{3}{3}$); the teeth are rootless and prismatic, but of very simple structure, as the name *Haplodon* (simple-tooth) indicates; the special pattern of their crowns is, however, unique. In such a structure it is obvious that we have here a connecting link between the beaver and the squirrel families. The general economy of the sewellel, as far as known, resembles that of a woodchuck. It enjoys little distinction among white men, and is hardly known except to naturalists; but it has long been hunted by the Indians, who use its skin for robes, and doubtless also eat its flesh, as they do everything else that can sustain life. It is not probable that *Haplodon* would very long survive the settlement of the small area it inhabits.

The family SCIURIDÆ, or Squirrels, is by far the largest of the Sciurine series, and its typical members are the most highly specialized of rodents. Nevertheless, the Sciuridæ offer for consideration a wide range of variation which passes by very gentle gradations from the large, heavy, terrestrial and fossorial marmots, or ground-hogs, with their short limbs, ears, and tail, on the one hand, through the chipmunks, which stand exactly on the dividing line, to the agile, graceful, and perfectly arboreal squirrels, whose trim limbs and long shadowy tails present the opposite end of the series, the extreme link of which is furnished by the almost aerial flying squirrels. Throughout these modifications of outward form, and consequently of habit, one set of technical characters prevails. The skull has large and distinct post-orbital processes, not developed elsewhere in the Sciurine alliance. There are normally two premolars on each side above, and one below; the first of these, however, is always small, and often deciduous, so that different individuals of the same species even may have the back teeth $\frac{10}{8}$ or $\frac{8}{8}$. The molars are rooted and tuberculate; the palate is broad and flat; the infra-orbital foramen is small and anterior in position. Cheek-pouches are frequently developed, especially in the ground-squirrels. The tail ranges from a stump to the elegant bushy appendage which may surpass the head and body in length and width, and by the distichous arrangement of the hairs furnish a kind of awning to cover the animal; whence the pretty name of "shade-tail" (*Sciurus*), which the Greeks and Romans gave. There is, perhaps, no more closely and evenly linked chain of animals, of equal extent, than that which has a woodchuck at one end and a flying-squirrel at the other.

Two sub-families are commonly recognized, Arctomyinæ and Sciurinæ, or ground-squirrels and tree-squirrels; but they blend in the genus *Tamias*, so that no positive characters can be ascribed, though the average differences are considerable, as just noted. The family, as a whole, is nearly cosmopolitan, being absent only from the Australian region. Tree-squirrels abound in the torrid as well as the temperate zone, while the ground-squirrels are more northerly on the whole, being confined to temperate and colder latitudes. The centre of abundance of the former is the Indian region; the Ethiopian has a long list of species; North America comes next; while South America and Europe are very poor in Sciurinæ. North America is richest in the Arctomyinæ, her ground-squirrels being numerous and diversified; Asia is next most so.

The marmots proper, woodchucks, or ground-hogs (*Arctomys*) are the largest and heaviest animals of the family, measuring up to two feet in length, with short bushy



Arctomys bobac, bobac.

tail, low ears, and long coarse hair. Cheek-pouches are small or wanting, and the claw of the thumb is a broad, flat nail; the skull is massive, not far removed from the condition found in *Haplodon*. These well-known animals inhabit North America, Asia, and Europe up to quite high latitudes, and also various Alpine localities. The principal Old World species are the Marmot proper (*A. marmotta*), and the Bobac (*A. bobac*), each of which occurs both in Europe and Asia. There are three distinct North American species; the Woodchuck (*A. monax*), so generally distributed in the United States and Canada; the Yellow-bellied Marmot of the Rocky Mountains (*A. flaviventris*); and the large Hoary Marmot or Whistler of more northerly regions (*A. pruinosus*). Marmots generally live in colonies, in burrows or among rocks; but the woodchuck is more solitary in its habits, as its name *monax* (the monk) implies. All these animals hibernate; the appearance of the woodchuck early in the spring, after his long retirement, is a weather prophecy generally credited by the rural population as good for the next six weeks, and no doubt this four-footed prophet is more reliable than some of the human weather-wise. "Woodchuck-day" is even set down in some rustic calendars; but it seems to shift like the movable holy-days of the Mother Church and her recusant Anglican offshoot. When numerous, the "chucks" are a great pest, for they eat everything green, and are almost ineradicable. Though quite terrestrial, they make shift to climb, and are often seen on fences and in low trees.

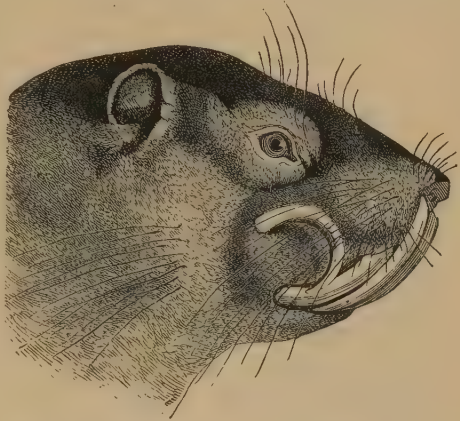


FIG. 66. — Head of woodchuck with deformed teeth.

Though the Prairie Marmots of the genus *Cynomys* are smaller than the foregoing, they are even stouter in form, with very sturdy organization, powerful dentition (the broad molar series convergent posteriorly), and the shortest tails and lowest ears of any members of the family. They are close-haired, even to the tail; the cheek-pouches are small; the nail of the thumb is well developed; and the forepaws with their crooked claws, are very effective instruments for the mining operations in which the lusty and truculent little creatures engage so extensively. These famous quadrupeds, universally known in Western parlance as "Prairie-dogs," from the sharp barking cries which they incessantly reiterate, inhabit the Western prairies and mountain plateaux of North America, from the eastern edge of the plains to the Pacific slopes, and from British America, among the northern tributaries of the Milk River, nearly or quite to the Mexican border. There are two distinct species, whose range is, on the whole, separated by the main chain of the Rocky Mountains — *C. ludovicianus* on the eastern side, *C. columbianus* on the other. The former is some thirteen inches long, the tail three or four inches. The pelage is short and coarse, and on the back (as in the case of various ground-squirrels) it appears as if sand-papered down, being actually abraded by incessant contact with the ground in rubbing through the burrows. The color is a pale or hoary chestnut-brown, pencilled with black hairs, giving way on the underparts to soiled whitish or pale ochre. The tail is tipped and bordered part way with blackish, furnishing one of the distinctions from the other species, which is a smaller one, with shorter and lighter-colored tail. The prairie-dogs live in colonies, sometimes

of immense extent; one may travel for hours through these great encampments, or "dog-towns;" the hillocks everywhere, each with its tenant bolt-upright at the mouth of his hole, with the fore paws folded down, vociferating his curiosity or displeasure, and on too near approach ducking down like an automaton on springs, with a saucy "good-by—I-have-business" flirt of the tail. These sharp cries are incessant; as each note is emitted the body shakes and the tail jerks, the whole appearance being ludicrously like a toy barking-dog, which squeaks and drops the jaw as you press the little bellows. The mounds amount sometimes to several bushels of dirt, brought up from below, and



FIG. 67. — *Cynomys ludovicianus*, prairie-dog.

also in some cases scraped together to improve them as observatory-stations; they are often repaired with care, and well-worn tracks usually radiate from them in every direction. The subterranean galleries are of great extent—so great that one would hardly think of trying to dig out or drown out the occupant. Sterile, sandy, or gravelly soil seems to be preferred, and places where the creatures are most abundant are usually in the most arid and desolate regions, where, furthermore, the scanty herbage is so nearly cleared away that one wonders how so many animals can find sustenance, to say nothing of water, of which element they appear to be almost independent. *Cynomys* is not easily captured or killed; and, when taken, long remains savage and intractable. But it may be tamed; and I have known a number to be domesticated—living in holes in the front yard of the house, coming when called to be fed, taking food from one's hands, and sitting on one's knee to eat it.

The myth of the communism fabled to exist between prairie-dogs, owls, and rattlesnakes, ought perhaps not to be brought up, even for the purpose of denouncing it as sheer nonsense. But we observe that "Cassell's Natural History" gives a wonderfully fanciful engraving, even though the very competent author of the article "Rodentia" in that work expressly says that this paradisiac picture is an imaginary one. I suspect this particular illustration originated in a flight of Teutonic fancy. The birds and the reptiles abound in the same regions the mammals inhabit, finding the deserted burrows of the latter eligible retreats, of which they avail themselves without stint. But the owls also burrow for themselves, in many cases at least. The true inwardness of their mutual relations is, that owls and snakes are enemies of each other, and both of the marmots. The birds would devour the young marmots if they could get at them, and do devour the young snakes; and the snakes devour the young marmots, the owlets, and the eggs of the owls.

The numerous species of Ground-squirrels (*Spermophilus*) present a series of forms graded from one extreme, in which the stout-bodied, short-tailed, crop-eared species are scarcely distinguished from *Cynomys*, to the other, where lighter-built species with high ears and long bushy tails resemble chipmunks, or even true squirrels. All have cheek-pouches, and appear to preserve both the upper premolars. The thumb is short, but furnished with a claw, not a nail. These animals are highly developed in North America, where a dozen species inhabit the country from the Mississippi valley (in a broad sense) west, southwest, and northwest to the Pacific, Mexico, and Alaska; none, however, occur in the Atlantic States. They are often called "gophers," and in cultivated regions are almost as obnoxious as the true gophers (*Geomyidae*). The habits and characteristics of the short-tailed prairie species, like the Tawny Spermophile (*S. richardsoni*), for example, which abounds in the upper Missouri and Milk River region, might be described in almost identical terms with those used in speaking of the prairie-dogs, though they scarcely colonize in such numbers, and do not burrow so deeply. They are smaller than the species of *Cynomys*, and lighter-colored. The opposite extreme is furnished by such a species as *S. franklini*, the "Gray Gopher," or "gray prairie-squirrel," which reminds one of the common Gray Squirrel (*Sciurus carolinensis*). This is nine or ten inches long, the bushy tail six or seven, the ears quite high. It is one of the most eastern species, extending from Indiana and Illinois to Kansas, Nebraska, and Dakota, and northward to 64°. Another large squirrel-tailed species is *S. grammurus*, which in some of its varieties extends from the Rocky Mountains to the Pacific, and from Oregon into Mexico. It is so squirrel-like, in fact, as to form by itself a subdivision of the genus, characterized externally by the size of the tail and ears. A variety of this animal (*beecheyi*) is the great pest in the cultivated portions of California, where it is extremely abundant. The prettiest species of the genus—one of the smaller kinds, found far eastward with *S. franklini*—is the Thirteen-lined or "Stars and Stripes" (*S. tridecemlineatus*), curiously so named for the original States of the American Union, in an outburst of Yankee patriotism. The ground-color is a rather dark reddish-brown or blackish-brown, on which are curiously traced six or eight light lines, alternating with five or seven rows of light spots; the rather narrow tail is yellowish-brown, bordered all around with black, this again with the yellowish tips of the hairs. It is six or eight inches long, the tail about four and a half, including the hairs; the ears are closely cropped,—a mere rim. Another elegantly-marked species is the Mexican Spermophile (*S. mexicanus*), about eight inches long, the tail to the end of the hairs five or six inches; of a dark brown color,

with about ten rows of squarish white spots, and the tail framed in a black border. *S. pilosoma* is another spotted species of Mexico and the southwestern border. Parry's Marmot-squirrel (*S. empetra*) is a large species of the high North and Northwest, with small ears, a short but bushy tail; it is very variable in color, according to locality, but is usually mixed black and tawny, with crowded white spots, the top of the head chestnut-brown, the under-parts rusty white. This *Spermophile* is related to some Old World forms, of which the best-known is the Souslik (*S. citillus*) of Europe and Asia. Several other species inhabit each hemisphere. All of them are bright, active, and industrious creatures, more or less sociable and gregarious in disposition, often seen playing about in the vicinity of their burrows, into which they scamper on the least

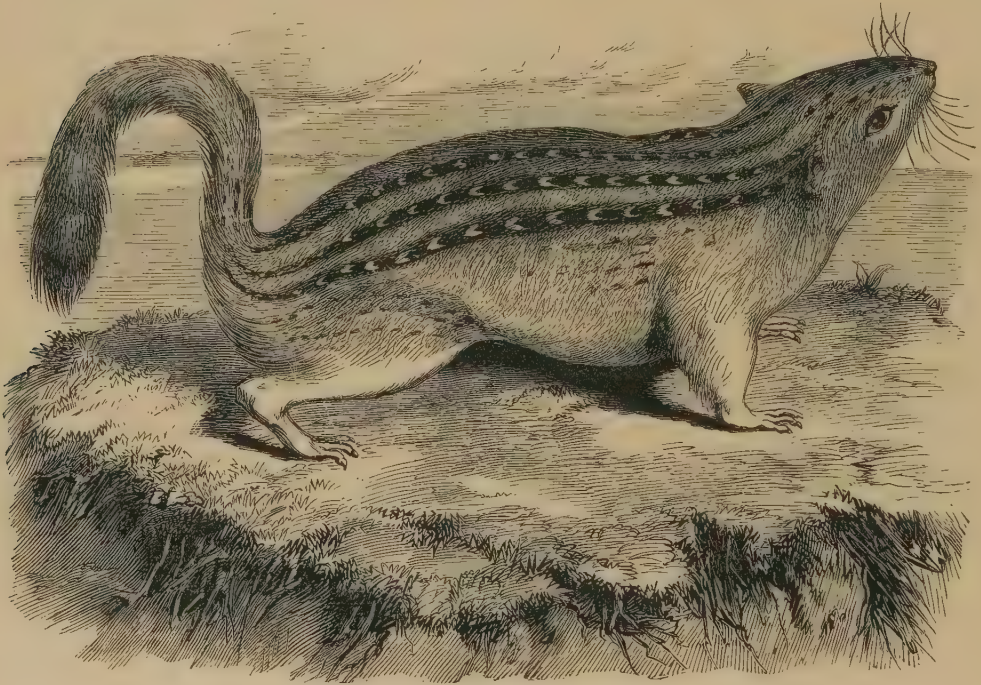


FIG. 68. — *Spermophilus tridecem-lineatus*, thirteen-lined spermophile.

alarm, never popping their noses above ground again till they think the coast is clear. They have a very characteristic habit of sitting bolt-upright, with the paws demurely hanging down or even crossed, as we so often hold our hands in deprecatory moments. They lay up great stores of provisions in their underground retreats, and usually hibernate in winter. But this depends entirely upon the species, and even upon the latitude, in the case of the same species. They are very prolific; the mammæ are usually eight or ten, and there are sometimes twelve, in six pairs.

It is a very short step from the *Spermophiles* to the Ground-squirrels proper, or Chipmunks (*Tamias*),—a small genus comprising some of the prettiest and most familiar representatives of the family, in all respects standing exactly between the two extremes pointed out above. In fact, one species has usually been called *Spermophilus*, and another was known as *Sciurus* before the genus *Tamias* was established. Cheek-pouches are best developed in this group. The teeth vary; some species retain

both upper premolars ($\frac{3}{2}$), as in the foregoing genera, while one species drops one of them ($\frac{2}{2}$). All agree in possessing tasteful stripes of color on the back and haunches; they are all small, with good ears and a flat bushy tail, from one-half to the whole length of the head and body. One of the species, the smallest (*T. asiaticus*) is common to both hemispheres, but in North America runs into several varieties, usually given distinct names. The Four-striped Chipmunk (*T. quadrivittatus*) is the best-known, having a very wide distribution, nearly co-extensive with that of the whole genus *Spermophilus*. This has on the back four white or whitish stripes, enclosed within five black or dark ones; the flanks bright rust color. It is the smallest species, only four or five inches long, the slim tail about as much more. It varies greatly in coloration, according to locality. The Eastern Chipmunk (*T. striatus*) is larger, with a relatively



FIG. 69. — *Tamias striatus*, chipmunk.

shorter and less flimsy tail, about three-fourths as long as the head and body; the coloration is livelier, becoming quite reddish on the haunches, and there are five black stripes, but only two white streaks, one on each side of the body. This is the bright and engaging little fellow that we see trailing along the fence-rail or the top of the stone-wall, scampering home with his cheeks puffed out, crammed with seeds or nuts—to make room for which we may fancy he dispenses with one pair of the teeth which *quadrivittatus* finds it convenient to retain. The Mountain Chipmunk (*T. lateralis*) is a larger and shorter-tailed species of the whole Rocky Mountain region, from Mexico to lat. 57° at least; it is about eight inches long, the tail, with the hairs, only four to four and a half; the coloration light brownish-gray, whitish below, with two black stripes on each side, enclosing a white streak. *T. harrisi* of the Southwestern Territories is a related species, quite similar to the last, with two white stripes, one on each side, which, however, are not set in black. These chiefly inhabit rocky places, and the

“windfalls” which often make travelling in the Rocky Mountains so laborious; but they also climb trees very readily.

We are thus brought to the true arboreal squirrels — those agile and graceful creatures which find their home in the trees, under the double umbrage of the foliage and their own shady tails. *Sciurus* is a very large and nearly cosmopolitan genus, of numerous species differing in details of form, size, and coloration, yet withal so much alike that almost any one species might serve to illustrate the whole, — and who is there to whom a squirrel is not one of the most familiar of animals? The Greek *skiouros*, the Latin *sciurus*, the French *escureuil*, or *écureuil*, the English *squirrel* (formerly spelled *squyrrell* and in other ways), are all the same word, indicating the chief ornament of the creatures, — which, when they are sitting up and handling their nuts so adroitly, curves over the back as far as the arch of the body, and then curls gracefully away, like the revolute scroll of a Corinthian capital; or, when the little animals run about, trails, lightly arched, after them like a fox’s brush. The species to which the name was originally applied is, of course, the common European one, now known as *Sciurus vulgaris*, type of the whole genus. It most resembles the Chickaree of North America (*S. hudsonius*). The latter country is rich in squirrels, harboring many other species, which, collectively, represent all but one of the leading modifications of the genus. But before mentioning any of these, we must call attention to some technicalities.

No animals are more inconsistent than squirrels in coloration. Leading, as they do, the most active lives, playing incessantly in light and shade, and constantly exposed to those subtle influences which affect the tints of natural objects, they present such variations as to have given rise to the saying among trained naturalists that “color is nothing in a squirrel;” and one who incautiously relies too much upon coloration in discriminating species will learn by humiliating experience how much truth there is in the adage. I do not mean that color, and especially the pattern of coloration, should not be used as a specific character; indeed, there is often no other; nor that comparatively slight differences in coloration may not truly stamp geographical races; but that color-tests of species must be judiciously applied. Squirrels are peculiarly liable to be affected by the accidents of melanism and erythrism. The former may produce a perfectly black individual from gray or reddish parents; while the latter sometimes so profoundly touches the organism that even the bones are reddened. Albinism, on the contrary, is very rare among these rodents, though white mice and white rabbits are common enough, as every one knows. Ignorance of the laws of color-variation has caused nominal species without number to be introduced in the scientific system. For example, four-fifths of the described species of North America are mere varieties, or pure synonyms. No more than six perfectly distinct ones are known to inhabit North America, north of Mexico, out of the great number described and figured by Audubon and Bachman, and the more moderate list given by Baird twenty-five years ago. And until the species of other parts of the world have received the same critical study which Allen and Alston have so successfully applied to those of America, it will remain futile to attempt to guess how many kinds there really are. The Indian species, in particular, are very numerous, and in a state of dire confusion. Africa also presents a long array of species, but somewhat better determined. Mexico and Central and South America have eleven or twelve species, all but one or two of them confined to those countries.

The African squirrels in general show a tendency to have scant-haired and harsh,

or even hispid coats; and in some cases this condition reaches the extreme in which spines are developed among the coarse and staring hairs. This state, when fully established, constitutes the genus *Xerus*. Such a species as *X. rutilans*, some twenty inches long, with low ears and rather terrestrial than arboreal habits, would seem to represent the spermophiles in the Ethiopian regions. But the transition does not seem to be abrupt; and an approach to the same condition is to be noticed in some of the Central American squirrels. We have also seen that the development of spines in the fur is no uncommon thing in rodents of warm countries; for, aside from the porcupines, we have several instances in the Octodontidæ, Saccomyidæ, and Muridæ. It is parallel with the tendency of numberless plants to become prickly in hot, dry regions, by hardening of the tissue, their twigs, and leaves into thorns.

These "Hedge-hog squirrels," as they may be termed, being put aside, the six North American species very well illustrate the whole genus.

We note, in the first place, that no unvarying dental formula is applicable. At different ages, the same individual may have one or two upper premolars on each side, according to whether or not it retains the minute anterior one. Such is the case with the small red squirrel. The various "gray" squirrels appear to retain both, as a rule; on the contrary, in the large "fox" or "cat" squirrels, one is the normal number.

The Chickaree, or Hackee, or Red Squirrel (*S. hudsonius*) is one of the smallest and prettiest species in America, representing the common European squirrel. It is the northernmost of all, ranging from the northern tier of States and Territories (in alpine regions further south) to the limit of trees in British America, and being in the greater part of this range the sole representative of its genus. It connects with *Tamias* in the smallness of the tail, which, with the hairs included, is shorter than the head and body; and also in the presence of a sharp black streak along the flanks. The length is usually only eight inches, sometimes less. The upper parts are more or less reddish; the under are usually white; the tail rusty with a black fringe. The ears are commonly tufted with a pencil of hairs, at least in winter. In the West it runs into three color-varieties, which, as they correspond with definite faunal areas, are regarded as good sub-species. The Chickaree so abundant in the Rocky Mountains, at least as far south as Colorado, is one of the best-marked of these (*S. fremonti*).

The "gray" squirrels are another group of species of medium and rather large size, with more or less fulvous in the gray of the back and flanks. The Gray Squirrel (*S. carolinensis*) is the best-known example of this style, being common in Eastern North America, from Canada to the Gulf, but not found in the West. It averages about ten inches in length, — the tail rather more, — but varies greatly in size; Southern specimens being smaller than Northern ones, and also browner. This coloration runs into melanism, the gray squirrel being sometimes perfectly black; and a large Northern example of this kind is obviously liable to be mistaken for a black-fox squirrel (see beyond). In the Southwest a similar gray squirrel occurs, and extends from Arizona into Mexico (*S. arizonensis*); it appears to be a perfectly distinct species, with a very large tricolor tail, much exceeding the head and body in length. The most beautiful and one of the largest species is the chestnut-backed Gray Squirrel (*S. aberti*) of the southern Rocky Mountain region, nearly or about a foot long, with a magnificent brush of still greater dimensions; the ears tufted as in *S. vulgaris* or *hudsonius*; the color pure dark gray, white below, with a bright chestnut band on the back, and a black flank stripe. This is often melanistic; but even when jet black, as often happens, may usually be recognized by the pencilled ears. Yet another and very remarkable

gray squirrel is the *S. fessor* of California, of large size, pure dark gray above, and pure white below, with a beautiful silver-black tail.

The greater portion of the United States, east of the Plains, harbors very large squirrels, known as "Fox" or "Cat." The size is usually about twelve inches in length of head and body, which is about equalled by that of the tail; but the color is wholly indeterminate. These squirrels, however, are generally distinguished by their reddishness, especially on the under-parts, where all the foregoing are usually white; and this ranges, through various dusky stages, to jet black. Three varieties of this species may be recognized. The Black Squirrel of the South Atlantic and Gulf States (*S. niger*) is distinguished by its maximum size, which is about thirteen inches, and the fact that the nose and ears are always snowy-white. Another variety is the common Fox Squirrel of the Middle States, from New England to Virginia (*S. cinereus*). This runs through all the colors of the last-named, but when black never has the white nose and ears of the other. This would, of course, distinguish it from the last-named, but also prevent its ready discrimination from a perfectly melanistic specimen of *S. carolinensis*. It is longer, however, and seldom lacks some reddishness on the under-parts, where *S. carolinensis* is normally white. It also normally lacks the small upper premolar which *S. carolinensis* usually retains. Finally, the Western Fox-squirrel, of the whole Mississippi valley (*S. ludovicianus*), is more constantly and very strongly reddish, not only on the under-parts, but on the feet and ears, and in the bones; it is seldom dusky, and perhaps never jet black.

These remarks, cursory as they are, may serve for the recognition of any North American squirrel; but it would take us far beyond our limits to notice those of other countries in like manner.

Even in the summary way we have reviewed the great order Rodentia, *currente calamo*, we have seen that one type of structure has been carried into the most diversified details, fitting the various animals for their no less multifarious rôles, and especially conferring upon them every mode of locomotion, saving only that which a bird enjoys; and in the remaining members of the Sciuridæ, as in all those of the family which is to come next, we find an extraordinary modification of structure, which confers upon its favored possessors the power of sailing through the air with the buoyancy of a parachute.

The elegant and dainty little Assapan or Flying-squirrel of America (*Sciuropterus volucella*) possesses a fold of skin on each side of the body, between the fore and hind limbs, attached to both as far as the wrist and ankle. In the ordinary movements of the body, which differ in nowise from those of other squirrels, this membrane reefs in close to the body by its own elasticity; but it is put upon the stretch when the limbs are stiffly extended, greatly increasing the surface of the body. Bounding lightly into the air from the swaying summit of a tall tree, spreading its "wings" for a flying leap of marvellous extent, with no net set to catch it in case of accident, this most daring of trapezists glides smoothly and swiftly on an inclined air-plane for thirty, forty, even fifty yards; when a movement of the rudder-like tail guides the body upward for an instant, with half a somersault, and the creature settles as light as a feather upon bough or trunk of the tree for which it set sail; then it scampers up to the top, and is ready to repeat the fun. This aerial sport is indulged chiefly in the dusk of the evening; and, in places where flying-squirrels are abundant, a dozen or more may sometimes be seen enjoying themselves together, gliding noiselessly through the gathering shades, like disembodied spirits. But if we examine one closely, we shall find it to be



Pteromys petaurista, taguan.

a very substantial little creature, not in the least like a spook, but cosy and comfortable, and inclined to be very friendly as soon as its natural fear of man subsides. It is about six inches long, the tail nearly as much more, flattened like an ordinary squirrel's, but much more copiously hairy, and so more compact; the fur slate-gray, overlaid with mouse-brown on the upper-parts, whitish below, and exceedingly fine, soft and silky, like a chinchilla's; the eyes large and expressive. These little creatures make amusing and engaging pets, as might be supposed. We have but one species in America, *S. volucella*, which ranges from portions of British America to Guatemala, and entirely across the Continent. In this wide range, it runs into several geographical races, distinguishable chiefly by size, but to some extent by color also. Their domestic economy is the same as that of ordinary squirrels; they live in nests, either placed in



FIG. 70. — *Sciuropterus volucella*, flying squirrel.

the holes of trees, or more artfully constructed of leaves and twigs made into a large ball, and hung in a forking of the branches.

These small flat-tailed Flying-squirrels, of which the Palatouche of the Old World (*S. volans*) is another example, were formerly called *Pteromys*. But this generic name should be restricted to the larger Asiatic and Indian species, which have cylindric tails. These are chiefly nocturnal, like the *Sciuropteri*; and this is the principal distinction in habits between flying-squirrels and other members of the family. The Taguan (*Pteromys petaurista*), for example, is the largest of the Sciuridæ, being some two feet in length, with the bushy tail nearly as long. Numerous other species of the same genus are described.

The curious creatures known as Scale-tailed Squirrels, which form the family ANOMALURIDÆ, may be described as flying-squirrels with climbing-irons;—the under-side of the tail being furnished for some distance from the root with a series of large horny scales, which, when pressed against the trunk of a tree, may subserve the same purpose

as those instruments with which a man climbs up a telegraph pole to set the wires. The parachute is similar to that of the true flying-squirrels, but is attached to the fore limb at the elbow, instead of the wrist, and is therefore less extensive. There is some resemblance to the genus *Galeopithecus* (of the Insectivora), but the long hairy tail is nearly free from the intermembral membrane. The back-teeth are $\frac{3}{3}$, there being no small anterior upper premolar. Post-orbital process are deficient, and there are some other cranial characters, among them the large size of the ante-orbital foramen, which



FIG. 71. — *Anomalurus*.

recalls a hystricine type. There are sixteen dorsal vertebræ, and as many ribs, three or four more than in the *Sciuridæ*, and some other peculiar internal arrangements; but the technical characters, no less than the general aspect of the scale-tails, are unmistakably sciurine, while their habits, as far as these are known, appear to correspond. Several species are described, all from the West Coast of Africa, as *Anomalurus fraseri* from the Island of Fernando Po, and *A. fulgens* from the Gaboon. The latter is about fourteen inches long, with the tail half as much more, and is of a bright reddish color.

Some of the extinct relatives of the *Sciuridæ* have been noted already in speaking

of the fossils related to the Castoridæ. But a considerable number of true Sciuridæ, belonging to genera now living, have been found fossil, carrying the actual family history to the upper eocene; while several genera believed to be of Sciuridæ, yet distinct from any which have survived till to-day, have been described. Such are *Plesi-arcetomys* and *Pseudosciurus* of the upper eocene of Europe; with *Sciuravus*, *Paramys*, *Heliscomys*, *Mysops*, *Colonomys*, *Taxymys*, and *Tillomys*, from the Tertiary formations of Western North America.

But we have reached the end of the chain of rodent beings of the earth, the water, and almost of the air; a cycle of mammalian life which circumscribes extraordinary diversity of form and function, revolving about a single central point of organization, namely: adze-like teeth to gnaw wood with. The number of individuals which make a living in this way in a world of Malthusian strife is simply incalculable — possibly there are more rodents than all other quadrupeds put together. They are necessarily small animals; were they as large as hoofed herbivorous quadrupeds, the earth would not sustain such myriads. Yet they have one obvious part to play, in common with the great Pecora and other ungulates, — that of turning grass into flesh, in order that carnivorous Goths and Vandals may subsist also, and in their turn proclaim, “All flesh is grass”

ELLIOTT COUES.



Shoet'l or Sewellel.

ORDER III.—INSECTIVORA.

Certain small mammals, with carnivorous tendencies, but whose inferior size compels them to resort chiefly to invertebrates, and especially insects, for prey, have been, on that account, designated as Insectivora. Inasmuch as they differ considerably in the development of the incisor teeth, they were distributed by Linnæus among several orders. Subsequent naturalists recognized their similarity in spite of such differences, and Cuvier, in 1816, combined them in a group, or "family," of his "Carnassiers," which he named "Insectivores." This group was later raised to independent rank, and has long been known as the order of Insectivores, or, as Latinized, Insectivora. It embraces the animals popularly known as shrews, or shrew-mice, moles, and hedgehogs, and others related to them found in warmer regions. But, in addition to the forms formerly and universally recognized as insectivores, recent naturalists have referred to the order the colugo (*Galeopithecus*), originally considered to be related to the lemurs, accepting, in this respect, the long-ignored opinion of the brother of the great naturalist, Frederic Cuvier. The various types of Insectivora vary so much in external characteristics that it is only possible to give general characters to the order. The following definition, which for exactness and conciseness is necessarily couched in technical language, is sufficiently exclusive as well as inclusive.



FIG. 73.—Skeleton of *Erinaceus europæus*.

Placenterous mammals, with a brain whose cerebrum is small and unilobate (the sylvian fissure being obsolete, and the posterior lobe undeveloped), leaving exposed behind much of the cerebellum, and in front much of the olfactory lobes; with the anterior as well as posterior members primarily adapted for walking, the carpal bones of the proximal as well as distal series, and the metacarpal as well as phalangeal bones being normally differentiated and developed; the ulna and radius more or less distinct; the hind limbs normally related to the pelvis, and their elements to each other, and without a "calcar"; with the teeth encased in enamel, of three kinds (molars, canines, and incisors), and with first and second sets; the lower jaw with well-defined condyles received in special glenoid sockets, and with the placenta deciduate and discoidal.

These characters, as a whole, are peculiar to the order Insectivora, although most are shared with one or another of the related orders. But the limbs distinguish the type from the bats, although they are subject to much secondary modification. The colugos are even adapted for flight, but their fore limbs, nevertheless, terminate in true feet, and are not specialized for the support of a flying membrane like that of the bats. The enamelled and diversiform teeth, embracing both milk and permanent sets, distinguish them from the edentates. The teeth also, as well as the condyles of the jaws, separate them from the rodents. Finally, the brain and placenta contrast with those of the carnivores, and are reinforced by various other characteristics which prove that, although analogous to each other, they are but distantly related.

In the treatment of this order the correctness of the classification that has received the general approbation of special students of the group for some years past will be assumed, and we, therefore, at once commence with an exposition of the several types, commencing with the forms that appear to be the most generalized, or nearest to the primitive Insectivora.

It is obvious that the various insectivorous groups are resolvable into two primary sections, or sub-orders, which contrast with each other in many notable ways. The two sub-orders in question are the typical Insectivora, or Bestiæ, and the colugos, or Dermoptera. The former are ordinary quadrupeds as to style of progression, while the latter are modified for flight for short distances.

SUB-ORDER I. — BESTIÆ.

The quadrupedal, or non-flying Insectivora have the limbs fitted for the normal mammalian mode of progression by walking. The limbs are therefore, as usual, moderate in length, robust, and destitute, for the most part, of any investing membrane; the lower jaw has its condyles transverse, or inclined inwards, at least not extended outwards; the incisor teeth of the lower jaw are conical (not pectinated), and more or less like those of the upper jaw, the latter, as well as the anterior molars of both jaws, being more or less conical, and crowned with single-lobed summits.

But the animals thus agreeing differ greatly in superficial appearance, as well as in details of structure. Some, for instance, are covered with robust spines, which bristle all over the body, while others have the finest and softest fur; others, again, have barrel-shaped bodies, minute eyes, and wide and sharply-clawed fore feet, eminently fitted for digging; others are mouse-like in form, most at home while running along the ground; and others, still, are squirrel-like, and affect the trees. It might quite naturally be thought that the forms thus specialized would be most nearly related to each other, and would, in fact, form natural groups; that is, all the spiny species would be the most like each other, the mole-like forms in their turn alike, etc. The older naturalists, indeed, assumed that such was the case, and called all the insectivores armed with spines Erinaceidæ, the digging, barrel-shaped ones Talpidæ, and the mouse-like forms Soricidæ, or by names to that effect. When, however, the structure of the various animals became better known it was recognized that frequently the external characters were not only no sure guides to their true relationships, but that they were frequently very misleading, and at length zoologists have concluded to ignore such superficial features as primary characters, and to subordinate them to others that are less adaptive. The best index to the real affinities was then discovered to be the structure of the molar teeth, or at least of the hinder ones. All the Insectivora of the

northern hemisphere, or rather the temperate portions, have oblong molars with two V-shaped (W) ridges, while certain tropical forms have transverse molars (that is, they are very short in the line of the jaws), surmounted with but one V-shaped ridge. Those with two V-shaped ridges are called Dilambdodonta (from the Greek *dis*, double, the letter *λ*, lambda, and *odous*, *odonta*, teeth), and the others, with one V-shaped ridge, are conversely named Zalambdodonta (from the Greek *za*, signifying emphatically, the letter *λ*, and *odous*, *odonta*).

The insectivores with the zalambdodont molars are the most primitive, or at least are generally so considered, and will, therefore, first demand attention. The representatives of this group are divisible into several families.

The type which embodies in the simplest condition the zalambdodont dentition is the family of CHRYSOCHLORIDÆ, whose species are known popularly as golden moles, on account of the peculiar tint of the fur. But although the teeth are so simple, the organization otherwise is not indicative of inferiority, and, in fact, the type exhibits, in some respects, a high degree of specialization. As is suggested by the common name, the Chrysochloridæ are much like the moles of the northern hemisphere in appearance, but in details of structure are very different. The head is conical, with covered eyes and without external ears, or rather ear conchs; the legs are short, and the anterior pushed inwards, and the fore feet are fitted for digging, but contracted, and with the middle claw disproportionately enlarged; the skull is conical, not constricted between the orbits, and has well-developed zygomatic arches; the teeth are 36 or 40 in number (*i.* $\frac{3}{3}$, *c.* $\frac{1}{1}$, *pm.* $\frac{3}{3}$, *m.* $\frac{2-3}{2-3}$ on each side), and the molars very contracted, and with simple V-shaped crowns; the collar-bones are elongated, as are also the humeri, and the tibia and fibula are united.

In their habits and mode of life, as in appearance, the Chrysochlorids are the African analogues of the moles, and, like them, excavate extensive tunnels in the ground, wherein they seek their wormy prey. Their adaptation for an analogous life, however, is effected by quite a different modification of structure. "In order to admit of fossorial life, action, and progression in a confined space," says Dr. Dobson, the fore limbs "must be so placed that they project as little as possible beyond the sides of the body, while the normal length of the fore-arms is preserved, and the leverage of the muscles remains unaffected. This is effected in the true moles (1) by change in the position of the limbs caused by anterior elongation of the *manubrium sterni*, and carrying with it the clavicles, and (2) by shortening of the clavicles, which is here carried out to the greatest extent known, the limbs being thus brought opposite the narrowest part of the body, and, as it were, articulated with the sternum, from which the small quadrate clavicles alone separate them. In the golden moles, however, the *manubrium sterni* is not anteriorly elongated, neither are the clavicles shortened; but this is made up for by a deep hollowing out on either side of the antero-lateral walls of the thorax, the ribs in these parts and the sternum being convex inwards, the long clavicles have their distal extremities pushed forwards, and the concavities on the sides and inferior surface of the thorax lodge the thick, muscular arms."

At least five species of the Chrysochloridæ are known, and all inhabit Southern Africa. They are kept together in a single genus, *Chrysochloris*, by Dr. Dobson, but represent three quite distinct sections; the type, and oldest known species, *C. aurea*, is isolated in one, distinguished by 40 teeth, a vesicular projection in the temporal fossa, and moderate zygomatic processes; two others (*C. villosa* and *C. trevelyani*)

constitute another (*Chrysospalax*), having also 40 teeth, but no vesicular projections, and especially characterized by the upraised zygomatic processes covering the sides of the skull like a high collar or hood; and two others form the third (*Amblysomus*), recognizable by the development of only 36 teeth.

CENTETIDÆ is the family name of insectivores peculiar to the Malagasy region,—the island of Madagascar, etc. They have what has been called “a squat form,” forefeet fitted for running, a very short tail, and well-developed spines interspersed in the fur. The skull is sub-cylindrical, and not appreciably constricted behind the orbits, the lachrymal foramen opens close to the inner margin of the orbit, there is no sub-



FIG. 74. — *Centetes ecaudatus*, tanrec, two-fifths natural size.

optic foramen, and the squamosal bones are expanded outwards and backwards; the teeth are variable (*i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *pm.* $\frac{2}{3}$ - $\frac{3}{3}$, *m.* $\frac{3}{3}$), but the molars of the upper jaw form triangular prisms, with only single internal principal cusps developed, while the lower molars have very small posterior cuspidate ledges. The scapula has an obtuse metacromion process, clavicles are developed, and the tibia and fibula are entirely distinct from each other.

The Centetidæ are naturally peculiar to Madagascar and the neighboring dependent islands, and are represented by four species, illustrating three genera, usually known as *Centetes*, *Hemicentetes*, and *Ericulus*. The largest species is *Centetes ecaudatus*, or the Tanrec. Its head and body measure nearly a foot (eleven inches) in length. It is now found in the islands of Bourbon and Mauritius, as well as Madagascar, but has been introduced into the former by man. Its favorite food consists of earthworms. It is extremely prolific, or rather multiparous, and has been claimed to be the most so

of all mammals; according to Dr. Dobson "as many as twenty-one young are said to have been brought forth at a birth; and in the uterus of a pregnant female it was found that while twelve fœtuses were developed, fifteen ova had been impregnated."

Closely related to the Centetids are some small, recently discovered mammals, inhabiting Madagascar. They have even been referred to that family by Dr. Dobson, and such may be their proper place: but it seems best for the present to keep them separate, as they differ much in physiognomy and considerably in structural characters. They may therefore be considered as the representatives of two families, — the Oryzoryctids and Geogalids.

The ORYZORYCTIDÆ are like moles or shrews in appearance, have more or less elongated tails, and the fur is soft and dense, and without any harsh or spine-like hairs; the skull and dentition do not appear to differ very materially from the corresponding parts of the Centetids; the tibia and fibula are united together. Two generic types are known, *Oryzoryctes* and *Microgale*.

The *Oryzoryctes hova* is a mole-like animal, and is said to burrow in the rice-fields of Madagascar, and to be quite destructive to the crops. It is a small form, the head and body together measuring about three and a half inches, and the tail one and three quarters.

The *Microgale longicaudata* is noteworthy as having a tail consisting of more numerous vertebræ (forty-seven) than has any other mammal, although it scarcely surpasses, and sometimes does not equal, in this respect, the long-tailed manis, for that species has as many as forty-six caudal vertebræ. A congener of this species, the *Microgale cowani*, has a very much shorter tail. Both kinds occur in the same part of Madagascar, are mouse-like or shrew-like in appearance, and about the size of ordinary shrews.

The GEOGALIDÆ are essentially similar to the *Microgales* in appearance, and have also a soft fur; the skull is somewhat intermediate in characters between those of *Microgale* and *Potamogale*, having the general form of the former, but with the peculiar shape of the palate and tooth-rows of the latter; the teeth, in the only known form, are reduced in number (*i.* 3, *c.* 1, *pm.* 3, *m.* 3); the molars have V-shaped cusps, with notched outer margins and an internal basal process as in *Oryzoryctes* and *Microgale*, but progressively increasing in transverse diameter, from before, backwards, as in *Potamogale*. The tibia and fibula are distinct.

Such are the characters assigned to *Geogale* by Dr. Dobson. The single known species, *Geogale aurita*, is about the size of a shrew, and inhabits the western portion of Madagascar. Nothing is known about its habits.

SOLENODONTIDÆ is the family name of two species of insectivorous mammals that inhabit the islands of Cuba and Hayti, one species being peculiar to and confined to each island. These are related not distant to the Malagasy Centetids, and were long regarded as belonging to the same family; but Dr. Dobson has considered the characteristics which differentiated them from the Centetids as sufficient to warrant their separation under a distinct family title. For insectivores, they are of large size, — about the size of a very large rat, — and they have a somewhat similar form, but the hind limbs are much longer, the feet more plantigrade, and the nose is produced into a long snout. No spines are developed in the hair, and the fur is quite soft. The

skull is slightly constricted behind the orbits; the lachrymal foramen nearly the same as in the Centetids; the squamosal bones are expanded outwards and forwards; the teeth are developed as three incisors in each jaw, three pre-molars, and three molars. The molars are essentially like those of the Centetids, and the scapula and clavicles are also similar to those bones in that family; the tibia and fibula are distinct. The organs of generation are, however, markedly distinct from those of the Madagascarene animals, and there are also some important muscular peculiarities.

The genus *Solenodon* is the only known form of this family now existing, and there are no recognized extinct forms which can be closely associated with it. It is entirely confined to the two large islands Cuba and Hayti, in each of which it has a special representative, and these are chiefly limited to the high, or mountainous parts of the respective islands.

The Haytian species, *Solenodon paradoxus*, was known as early as 1833, but the Cuban species, *Solenodon cubanus*, not until thirty years after (1863 or 1864). Little is positively known of the habits of either of the species. They are said, however, to attack the poultry of the plantations, and to make themselves known by a peculiar cry, which is described as being very loud and piercing. When pursued they are quite apt to run the head into any hole which they may find in their flight, and to therein conceal it, ostrich-like, leaving the rest of the body exposed, and thinking themselves thus secure. They manifest a psychological characteristic, in common with their relations, the shrews and moles, for it has been noted of an individual kept in confinement, that it was subject to excessively violent fits of rage when irritated. The Haytian animal is known in its country as the Agouta, and the Cuban as the Almiqui. The latter attains a total length of about nineteen inches, of which the head and body would measure eleven, and the tail, eight, while a somewhat larger size has been attributed to the Haytian species. The two, however, probably differ little, if any, in average size.

A peculiar and very distinct family, POTAMOGALIDÆ, contains the largest of living insectivores, an inhabitant of Africa, seeking its food and living almost all the time in the water,—the *Potamogale velox*.

It is eminently adapted for aquatic life and progression in the streams. The form is elongated and graduated into the tail, which is so very large and compressed that there is absolutely no noteworthy constriction marking the limits between it and the trunk. The head is produced forwards, in front of the eyes, into a robust snout. The legs are very small, especially the fore ones, but the posterior are larger; a web is developed between the toes of the hind feet, and the outer side of the walking surface is peculiarly flattened, the skin being drawn downwards, forming a thin lobe along the side of the foot. The toes are not webbed, but the second and third are united together for the whole length of the first joints; the three middle toes are about equal, the fourth is slightly longer; the extremities of the claws of the great toe and the outer toe reach to the basal joints of the next. The skull is cylindrical, and has no lachrymal foramen but has a sub-optic one; the teeth are forty in number (*i.* 3, *c.* 1, *pm.* 3, *m.* 3). Each upper molar presents a completely divided triangular prism, two principal internal cusps being developed, and the lower molars have quite large posterior ledges or areas. The shoulder bone has no metacromion process, and the collar bones are entirely wanting; the tibia and fibula are ankylosed together at the distal extremities.

Only one species of this singular type is known, and it is quite restricted in its distribution, for it has been found only in the Cameroon district, Old Calabar, and the Gaboon basin of equatorial Africa. Little is known of its habits, but, according to Du Chaillu, "it is found along the water-courses and limpid and clear streams, where fish are abundant, hiding under rocks, lying in wait for fish. It swims through the water with a rapidity that astonished me; before the fish has time to move it is caught." But, according to Dr. Dobson, that it feeds on fish cannot be at present confirmed or disproved, as no specimens appear to have been hitherto obtained in which the stomach and its contents have been found available for observation. "Such a diet would be wholly exceptional among Insectivora," and Dr. Dobson thinks it "more than probable that Crustacea and water-beetles contribute largely, as in other species, to its daily fare." We must remember, however, that the animal is adapted for rapid and efficient progress in the water, and it would not be surprising if its diet was also equally modified.



FIG. 75. — *Solenodon cubanus*, *almiqui*, one-third natural size.

Unreliable as Mr. Du Chaillu's statements often are, it is more than possible that in this instance he was correct. That the animal swims through the water as described above, Dr. Dobson well adds, "is quite evident from the form of its immense, laterally flattened, fish-like tail, which, moreover, as in many fishes, is doubtless the sole organ of propulsion, the short, unwebbed fore and hind limbs being folded on the sides and inferior surface of the body, as in a newt when swimming." The body of *Potamogale velox* is a foot long, and the tail nearly eleven inches.

Admitting all the families now enumerated as such, there are six of the zalambdodont series — Chrysochloridæ, Solenodontidæ, Centetidæ, Oryzoryctidæ, Geogalidæ, and Potamogalidæ. The first is so isolated as to represent a peculiar "super-family," — Chrysochloroidea, — while all the others belong to another, the Centetoidea.

The remaining types of walking Insectivora belong to the dilambdodont series, and may be most conveniently considered in the following order:—

In the islands of the Eastern Archipelago are found certain small mammals which

chiefly affect the trees, and in superficial aspect much resemble the squirrels, assuming similar attitudes, and coursing up and down the branches as they do. Like as they are, however, they have no relation to the true squirrels, but are insectivores modified for an arboreal life. Unlike most other insectivores they are especially diurnal animals, seeking their food and pleasure by daylight instead of in the night. The name which these animals bear in Sumatra is Tupai, and this they have in common with true squirrels, which are likewise found in the island, and with which they are confounded by the Malays. The common aboriginal name has been adopted, with a slight modification, as the scientific, and the family is called TUPAIIDÆ. In brief the Tupaiidæ are dilambdodont insectivores of a squirrel-like aspect, with very soft and fine fur, with the intestinal canal provided with a large cæcum, the tibia and fibula separate, the metatarsus moderate (little or no longer than the tarsus), the skull transversely convex above, the orbit more or less encircled by bone; with no sub-optic foramen; with the alisphenoid canal developed, the malar perforate, the lachrymal foramen at the margin outside of orbit, and thirty-eight teeth (*i.* $\frac{3}{2}$; *c.* $\frac{1}{1}$; *pm.* $\frac{3}{2}$; *m.* $\frac{3}{2}$).

The family of Tupaiidæ has two well-defined genera, *Tupaia* and *Ptilocercus*. *Tupaia* contains those which especially resemble the squirrel, from which, however, they are at once distinguished externally by the elongated, conical snout. These have a tail distichous like the squirrels. *Ptilocercus* in most respects differs little from *Tupaia*, but has a very peculiar tail; it is long, with the basal portion mostly naked, or rather covered with scales, and having only short hairs, while the terminal third has long hairs, distichous or diverging in opposite directions from the sides, thus resembling an arrow with its two wings.

The proper diet of the Tupaiids is small insects, but they are to some extent frugivorous, and in confinement they may be fed, according to Cantor, exclusively on either insects or fruit, although preference is manifested for insects. Their voice is a short, peculiar, tremulous, whistling sound, often to be heard in calls and answers, and this they emit, for instance, on the appearance of food, as well as other pleasurable emotions, while their displeasure is vented in shrill, protracted cries. Like the squirrels, their disposition is very restless, and their great agility enables them to perform the most extraordinary bounds in all directions. In such exercise they spend the day until night sends them to sleep in their rudely constructed lairs in the highest branches of the trees. At times they will sit on their haunches, holding their food between the forelegs, and after feeding they smooth the head and face with both forepaws, and lick their lips and palms. In this respect, as well as others, it will be seen they resemble the squirrels, and they carry out this likeness in captivity. When placed in a cage, according to the same observer, "the tupaia will continue for hours vaulting from below, back downwards, poise itself for an instant, continuing back downwards under the horizontal roof, and regain the point of starting, and thus describe a circle, the diameter of which may be three or four times the length of the animal, in far shorter time than is required for the description."

The species of *Tupaia* are eleven in number, and are mostly inhabitants of the Indo-Moluccan Archipelago; but several also occur on the mainland in India, and even extend into China. The most common and widely distributed are the *T. ferruginea* and *T. javanica*. The former is about sixteen inches long and the latter thirteen, the tail in each forming about half the length. Only one species of *Ptilocercus* is known, the *P. lowi*, and that is confined to the island of Borneo. Its head and trunk are five or six inches long, and the tail somewhat longer.

In Africa there live certain peculiar, shrew-like animals whose hind limbs are developed out of proportion to the fore, fitting them for jumping. They have been consequently called *MACROSCOLIDIDÆ* (which practically means the long-thighed animals), and jumping shrews. The typical species (*Macroscelides typicus*) has also been called "elephant shrew," not on account of its size, but in allusion to the elongated nose; and for the same reason the French call an allied species of Algeria (*Macroscelides rozeti*) "*Rat à trompe*." These animals have an intestinal canal provided with a large cæcum. The body is rat-like, and the pelage soft; the tibia and fibula are united below, the metatarsus is very elongated (much exceeding the tarsus); the skull is transversely concave above, the orbits are open behind and not encircled by bone, and a sub-optic foramen is developed, but there is no alisphenoid canal, and post-orbital processes are also wanting; the malar is imperforate, the lachrymal foramen



FIG. 76. — *Macroscelides typicus*, elephant shrew, one-half natural size.

is within the margin of the orbit; three incisor teeth are developed above and below on each side, and there are five toes to each of the fore-feet at least.

Of this family there are two generic types — *Macroscelides* and *Petrodromus* — confined to the African continent, but therein the former is quite generally distributed. As indicated by the length of their hind-limbs, they chiefly progress by jumps, and are very active. The species of *Macroscelides* live by preference on the plains, and are diurnal in their habits. Their insect prey is chiefly hunted for in the grass and bushes of their favorite resorts. They make burrows in the ground, and when alarmed run immediately thereto for safety. The hind-feet have each five toes, but the first is quite short. The species of *Petrodromus*, on the other hand, justify their name (rock-runner) by their habitat, the rocky hills being their favorite home. The hind-feet have only four toes each. Nine species of *Macroscelides* and one of *Petrodromus* have been described. The longest known representative of the former is the *M. typus*, introduced into zoology in 1829 from the Cape of Good Hope, and at the opposite extreme of the

continent another quite similar species, the *M. rozeti*, represents it. Both of these are nearly of the same size, — about eight inches long, of which the tail constitutes some three or four inches. The only recognized species of the latter — *P. tetradactylus* — was described by Peters, in 1846, from specimens obtained in Mozambique. It is the largest species of the family.

The “dark continent” has another peculiar type apparently of family value, but closely related to the Macroscelididæ. It is, however, limited to a single genus of about four species. The name, RHYNCHOCYONIDÆ, has been conferred on it on account of the enlarged canine teeth, combined with the elongated snout. The intestinal canal has a long cæcum; the general appearance is like that of a rat; the fur is soft; the tibia and fibula are united, and the skull in general is developed as in the Macroscelidæ, but it is broad between the orbits, and has distinct post-orbital processes; the infra-orbital canal is very long, the incisor teeth are reduced in number ($\frac{1}{3}$ or $\frac{2}{3}$) in the upper jaw, and the toes of the fore as well as hind-feet are only four in number.

The species of *Rhynchocyon*, so far as known, are confined to Eastern Africa, the oldest species, *R. cirnei*, having been obtained in Mozambique (Boror), the *R. petersi* in Zanzibar, *R. macrurus* by the River Rovuma, and *R. chrysopygus* by the River Mombaza; the last two were only described in 1881, and all are rare in collections. The best known, *R. cirnei*, has a head and body aggregating eight inches in length, and a rat-like tail little shorter. It is said to live in holes in the ground, and subsists on insects. It is a strictly nocturnal animal. This much is known, but what peculiarities of alimentation and habits are the co-ordinates of the structural characteristics are entirely unknown.

The three preceding families, in contrast with others, are rather closely related to each other, and are consequently combined as a super-family of dilambdodont insectivores under the designation of Tupaioidea. Another super-family, Erinaceoidea, appears to be demanded for the reception of the hedge-hogs, the genera of which form likewise the family of ERINACEIDÆ. These have no cæcum to the intestinal canal. The molar teeth and the premolars in part (*m.* 2, *m.* 1, *pm.* 4, and *pm.* 3) are quadricuspid with the antero-internal cusp higher than the postero-internal; the true molars (*m.* 2, *m.* 1) have the postero-external cusp connected by a ridge with the one between the antero-internal and the postero-internal cusps at the re-entering angle with the latter. The cranium is oblong-oval, and broadest between the roots of the zygomatica; the foramen magnum is triangular, the occipital condyles very divergent, and the paroccipital and mastoid processes distinct. The fur is more or less harsh or spiny, but the development of spines is of no special importance, and some of the forms have no true spines. The common hedgehog of Europe is the type of this family, and also the type around which cluster a number of species which together form the sub-family Erinaceinæ.

The Erinaceinæ, or true hedgehogs, have a rudimentary tail, and robust spines are developed in the pelage. The cranium is comparatively broad, scarcely constricted between the orbits, and has a short muzzle. There are only three incisors above and two below, and three premolars above and two below on each side, and the hindmost molars and the canines are small.

As many as nineteen species of hedgehogs are recognized by Dr. Dobson from different portions of the regions over which the family is distributed, and these have

been by some naturalists divided into two or three genera; they are, however, very much alike in anatomical features. There is not very much difference in size between the species, but the largest is the common animal of Europe, — *Erinaceus europeus*, — which reaches the dimensions of a large rat. This species is found, according to Dobson, in almost the entire Eur-Asiatic region, extending from Ireland to Eastern China, and from the Scandinavian Peninsula and Russia to Southern Italy, Asia Minor, and Palestine, and at heights varying from six thousand feet, in the Alps, to eight thousand in the Caucasus. It is somewhat abundant in Great Britain, in suitable localities, where there is thick cover, though less common towards the north. It was



FIG. 77. — *Erinaceus europeus*, European hedgehog, one-third natural size.

formerly asserted not to be found in Ireland, but this is incorrect. However, it is not so common as in England. It is a lover of a moist and humid climate, and as soon as rain sets in may be seen, but in very hot and dry weather it conceals itself in its burrow. The female is quite prolific, and produces from four to eight young in the months of July and August, but two to four is a more common number. She may have two litters in a year, one about May or June, and another in October or November. The period of gestation is about a month. The young are able to care for themselves as soon as they are born, but the spines are then undeveloped, being small, colorless hairs. These, however, soon become hard, and quickly assume the character familiar in the adult, the young attaining their full size in about a year.

The development of the spines is correlated with some interesting muscular peculiarities, and the efficiency of this provision for the safety of the animal has been well

described by Bell. Although "deprived by its structure of all means of attacking its enemies, of defending itself by force, or of seeking safety in flight, this harmless animal is yet endowed with a safeguard more secure and effectual than the teeth and claws of the wildcat, or the fleetness of the hare. Its close covering of hard spines, — which are hard without brittleness, sufficiently elastic to bear great violence without breaking, and fixed with astonishing firmness in the tough, leathery skin, — forms not only a solid shield to protect it from the effect of blows and falls, but a shirt of prickly mail sufficiently sharp and annoying to deter all but a few thoroughbred dogs from venturing to attack it. Immediately that it is touched, or that it sees danger approaching, it rolls itself up into a compact, round ball, by the contraction of the powerful muscles which cover the body immediately under the skin, and presents this impenetrable panoply, beset by innumerable spines standing out in every direction; the more it is irritated or alarmed, the more firmly it contracts, and the more strongly and stiffly the spines are set; and its appearance at such times did not escape the eyes of Shakspeare, and was not forgotten when he put the following in the mouth of Caliban: —

‘like hedgehogs which
Lie tumbling in my barefoot way, and mount
Their pricks at my footfall.’

"The strength and elasticity of this covering is such that we have repeatedly seen a domesticated hedgehog run towards the precipitous wall of an area, and, without hesitation, without a moment's pause of preparation, throw itself off; and contracting at the same instant into a ball, in which condition it reached the ground from a height of twelve or fourteen feet; after a few moments it would unfold itself and run off unhurt."

Another most interesting feature of the economy of the European species at least is its ability to store up in its tissues a sufficiency of fat to draw upon for support during a winter's rest, while it remains in concealment, alike free from the pangs of hunger and cold, as well as from the dangers incident to hunting in winter. Bell believes that "the hibernation of the hedgehog is, perhaps, as complete as that of any animal inhabiting England; and much more so than that of many of the Rodentia which retire, indeed, to winter retreats, but awaken at intervals, to eat of their treasured hoard of nuts or grain, when called into temporary life by a day of unwonted mildness. The hedgehog, on the contrary, lays up no store for the winter, but retires to its warm, soft nest of moss and leaves, and, rolling itself up into a compact ball, passes the dreary season in a state of dreamless slumber, undisturbed by the violence of the tempest, and only rendered still more profoundly torpid by the bitterest frost. Its usual retreats are in the hollows of trees which are decayed at the bottom of the trunk; underneath its base, where the earth has been washed away from under the huge, naked roots; in holes of rocks; on a dry bank in the bottom of a hedge-row; or under the brush-wood in a coppice or wood. We have seen their nests often in the latter situation, and composed entirely of withered leaves, the inner ones being perforated by the creature's spines, so that when removed from the nest it was yet enveloped by leaves. Withered leaves appear to be the best material for the nest, and are generally chosen, as they are singularly effective in keeping out the wet. We have always failed to discover the place at which the animal has entered this retreat, the entrance being most carefully closed behind it."

We are obliged to further borrow from Professor Bell. According to him, "the voice of the hedgehog is not often heard, but it is an odd sort of sound between a grunt and a low, piping squeak; and Shakspeare, who has shown us by more than one allusion how much he knew of the habits of so obscure a creature as the mole, has given us proof that he, too, was well acquainted with the voice of the hedgehog. We refer to the following in one of the witch-scenes in 'Macbeth':—

'Thrice and once the hedge-pig whined.'"

The *Gymnurinæ* have a more or less elongated tail, and no decided spines are developed in the pelage, although the hairs may be harsh and even rigid; the skull is comparatively narrow between the orbits, and the muzzle more or less elongated. There are six incisors in each jaw, and also four premolars on each side; the last molars are well developed, and the canine teeth are enlarged.

The best-known example of this group is the Bulau, *Gymnura rafflesii*. This has quite a different form from the hedgehog, and more resembles a rat in appearance. It is an inhabitant of Sumatra, Borneo, and Malacca, etc. Very little is known about its habits, but it is certain that it has not the ability to roll itself up into a ball like the true hedgehogs. Its legs are quite short, and all its feet are five-toed and furnished with curved, pointed claws. It reaches a total length of about twenty-six inches, of which the tail constitutes less than half, or about twelve inches.

Nearly related to the bulau is an animal which has been named *Hylomys swillus*, but which has been by most naturalists associated with the Tupaiids, although by Dr. Dobson it is regarded simply as a species of *Gymnura*. It is an inhabitant of Northern India, and is much smaller than the bulau.

By far the largest family of the insectivores—comprising over half of the living species—is that of the shrews, *Soricidæ*, or, as they have been not inaptly called, shrew-mice; for externally they have much resemblance to mice, the only salient feature distinguishing them to the casual observer being the elongated snout. The pelage in all is soft and furry, the skull has posterior ridges well developed, the infra-orbital canal is a rather long sub-cylindrical tunnel, covered by a very broad osseous wall; no zygomatic arch is developed; the lower jaw has its ascending rami deflected outward, and there is a cavity at the bottom of each coronoid process; the sternum has a broad manubrium which is not carinated, the anterior members are more slender than the posterior, and the carpus is normal, having no sickle-shaped bone or os intermedium. The dentition is very similar in all; the incisors are two in each jaw (*i.* $\frac{2}{2}$, *c.* $\frac{1}{1}$, *pm.* $\frac{3-4}{4}$, *m.* $\frac{3}{3}$); the upper incisors are curved and bear a pointed, spur-like cusp at their base; the lower ones are horizontal and enlarged.

Not only is the family the largest of the order, but it is also the most homogeneous of all those families which have several genera; for all the shrews are constructed on essentially the same plan, and differ only in matters of minute detail. They are also the most widely-distributed of the order, representatives being found in the Eur-Asiatic and American regions, and extending both to the north and southward, more than any other forms. But, though very uniform on the whole, the details of structure necessitate their differentiation into a number of genera, which may be combined under three sections: (1) the typical *Sorices*, of which the two genera, *Sorex* and *Blarina*, both occur in North America; (2) the *Crocituræ* with one widely-distributed genus common to the old world (*Crocitura*), and two Asiatic (*Diplomesodon* and

Anurosorex); and (3) the Crossopi, also with three genera, one American (*Neosorex*) and two old world forms (*Crossopus* and *Nectogale*).

The habits of shrews are known best as manifested in the Common Shrew of Europe (*Sorex vulgaris*). This chiefly lives in the coppice or woodland, in which situations, as well as in the open fields, whether cultivated or in pasture, they seek their food. But they are not confined in their habitat to such situations, as, with their congeners the water shrews, they are often met with in marshy and fen districts. They are not exclusively insectivorous, for they also feed upon worms and small molluscs, and they are probably only restricted by their size in their selection of food, for they will also devour meat in the shape of small birds and other animals, and often their own kind. "If two shrews be confined in a box together a very short time elapses before the weaker is killed and partly devoured." It will be thus seen that



FIG. 78. — *Crocidura araneus*, house shrew, and *Sorex vulgaris*, common European shrew, natural size.

they are very prone to combat, and jealous of each other's presence. On the other hand, the secretions which they emit are so offensive to some animals that although they may be killed they are not devoured. The shrews are very prolific, the female generally having as many as five or seven young ones at a time; they are mostly born in the spring. A nest is provided for them, "which consists of soft herbage, and is made in any hole or depression of the ground, or in a bank; it is covered over at the top, and is entered at the side," according to Bell.

The English naturalists record that the common shrew at least is subject to an epidemic, or a very general malady which prevails early in the autumn, the cause of which does not appear to be understood. "So many may be found at that season lying dead in footways, or on other bare ground near their haunts, as to have led to the belief among the country people that the shrews could not cross a public way without incurring instant death. We confess ourselves wholly unable to furnish any explanation," says Dr. Bell, "having failed to discover any cause of death. Amongst the many we

have ourselves picked up and examined have been individuals of both sexes and of all ages, as shown by the worn or unworn condition of the teeth, and the more or less naked state of the tail."

The shrews have been, to an unusual extent for small animals, the subject of superstition in Europe. One of these—the lethal penalty of crossing a road—has just been instanced; but this affects the animal alone, while the others reflect more upon its powers of injury to man. It is believed to produce disease or affliction to any part of the body which it touches, as, for example, lameness to the foot which it passes over, but antidotes have likewise been imagined to such calamities. The chief one was the twig of a shrew-ash. "Now a shrew-ash," according to Gilbert White, the natural historian of Selborne, "is an ash whose twigs or branches, when applied to the limbs of cattle, will immediately relieve the pains which beasts suffer from the running of a shrew-mouse over the foot affected; for it is supposed that the shrew-mouse is of so baneful and deleterious a nature that, whenever it moves over a beast, be it horse, cow, or sheep, the suffering animal is afflicted with cruel anguish, and threatened with the loss of the use of the limb. Against this accident, to which they were continually liable, our provident forefathers always kept a shrew-ash at hand, which, when once medicated, would maintain the virtue forever. A shrew-ash was made thus: Into the body of the tree a deep hole was bored with an auger, and a poor devoted shrew-mouse was thrust in alive, and plugged in, no doubt with several quaint incantations long since forgotten." According to Bell, "Another method of cure was to make the person or animal pass through the arch of a bramble, both ends of which were rooted and growing." Such superstitions, however, are gradually disappearing in England, and seem never to have secured a real foothold in the United States.

The House Shrew, *Crocidura araneus*, is found in the countries lying between North Africa and Northern Russia and Siberia, but appears to be lacking in England, Holland, and Scandinavia. The Ciliated Shrew, *C. suavolens*, which is found in all the countries bordering on the Mediterranean, is noticeable as being the smallest known mammal.

As has been above indicated, there are three genera of American shrews, *Sorex*, *Blarina*, and *Neosorex*. These may be recognized by the following marks:—

Sorex has no cilia to the feet, the ears are well developed, and the tail is moderately long. Perhaps the most common species in the Eastern



FIG. 79. — *Sorex platyrhinus*, broad-nosed shrew.

United States is the *S. platyrhinus* or broad-nosed shrew; others found in the same region are *S. cooperi* and *S. forsteri*. All these have thirty-two teeth, and constitute the restricted group *Sorex*. Another species, *S. hoyi* or *thompsoni*, has thirty teeth, and represents the group *Microsorex*; and a third group,

Notiosorex, has been proposed for a shrew, *S. crawfordi*, found in New Mexico.

Blarina, like *Sorex*, has ordinary feet, but the ears are very small and concealed in the fur, and the tail is very short. The typical species, called the Mole-shrew, *B. brevicauda*, is decidedly the most abundant of the family in the Eastern States



Crocidura suaveolens, ciliated shrew, natural size.



Tupaia tana, tupai, one-third natural size.

generally; it has thirty-two teeth. Another smaller species, distinguished by the development of only thirty teeth, is called *B. cinerea*, and has for that reason been set apart as the representative of a subgeneric group (*Soriciscus*) by Dr. Coues.



FIG. 80. — *Blarina brevicauda*, mole shrew, natural size.

Neosorex is the American representative of the Eur-Asiatic *Crossopus*, and has fimbriated or ciliated toes, the ears moderately developed, and the tail about as long as the head and body together. Two species are known,—the *N. palustris* of the eastern slope of the continent, extending from the Rocky Mountains to the coast, and the *N. navigator* of the Pacific slope, and especially of Washington Territory and



FIG. 81. — *Crossopus fodiens*, water shrew, natural size.

Oregon. These are as aquatic in their habits as the native Shrew of Europe, as has been suggested by their names. The Marsh Shrew (*N. palustris*) was observed by Professor Cope swimming in a lake in New Hampshire about forty feet from the bank, and Professor Verrill has directed especial attention to the valvular ears as well as fringed feet, as eminently fitting them for life in the water.

The Water Shrew of Europe, *Crossopus fodiens*, has the premolars $\frac{4}{4}$, and the feet and toes provided with rigid hairs. It is about three inches in length, the tail measuring about two more. It is of a dark brown color, inclining to black above and gray or white beneath. Like some others of the group, it burrows in the banks of streams and ponds, and is very aquatic in its habits.

Intermediate between the shrews and moles, to a certain extent, but much more allied to the latter, are a few animals forming the family MYOGALIDÆ, the chief of which are known as the Desmans, or *Myogalæ*. In form they resemble rather the shrews, but differ, even in this respect, and some approach nearer the moles in appearance. The anterior feet are comparatively narrow, and not especially fitted for digging, like those of the great burrowers. The skull has obsolete posterior ridges; the infra-



FIG. 82. — *Myogale moschata*, desman, one-half natural size.

orbital canal is very large, and arched over only by a narrow osseous bar. The zygomatic arch is very slender, and the lower jaw has erect ascending rami, and without cavities under the coronoid processes. The sternum has a manubrium of moderate size; the scapula is provided with a metacromion process; the clavicle is elongate, the humerus sub-cylindrical, and the carpus has no sickle-shaped bone.

The family embraces five known genera, of which the Eur-Asiatic region (including Europe and Northern Asia) has four, and the North American has only one. They are mostly small animals, but the type of the family, *Myogale moschata*, ranks among the largest of the order. The species just cited has a head and body aggregating nearly eight inches in length, and the tail is almost as much more. The two species of *Myogale* are both found in Europe, but have a remarkable restriction of range; the *M. moschata* is now limited to Southeastern Russia and Western Asia. Its congener, *M. pyrenaica*, is found only in the neighborhood of the Pyrenees

mountains. But in a period immediately preceding the glacial epoch a species of *Myogale*, identified with the *M. moschata*, extended westward as far as England, its remains being found in the forest beds of that country. Both the living species are aquatic, and live in still waters, from which they make burrows, often extending as winding passages, to a considerable distance, in the direction of the surface, "towards which they always direct them, probably on account of the greater looseness of the surface soil, and the necessity of obtaining air for respiration. These burrowing habits have evidently been handed down by remote ancestors, more fossorial than natatorial in their organization." Their food, judging from the remains found in their stomachs, "consists chiefly of water-beetles, and larvæ of different kinds, and it is probable that Crustacea and other invertebrate aquatic species of animals also contribute to it." They have very elongated flexible snouts, almost reminding one of the elephant's trunk in appearance; this is brought actively into play during the search for provisions. In the words of Dallas, "it is turned and twisted in various directions, touching the various bodies that come in the way, and is used to feel about for prey, which is seized and conveyed to the neighboring mouth after the same fashion as the trunk of an elephant." It is also said of the desman that the trunk is put into its mouth, and that it then utters a "cry like a duck; when irritated or threatened, it hisses and tries to bite." The name muskrat, which is one of the popular designations of the desman, is due to the singular development of glands above the tail, which is found only in that species, the *Myogale pyrenaica* having them at most in a rudimentary condition. "These glands are undoubtedly made up of aggregated sebaceous glands, as shown by their minute structure, their position and their secretion." The office of this secretion "appears to be protection to the animal, though, according to some writers, it occasionally falls a prey to pike and other carnivorous fishes, the flesh of which becomes tainted with the powerful penetrating odor. It is interesting to notice how the development of these glands appears to have resulted in a two-fold manner to the advantage of the species; in the first place by affording a protective fluid, rendering the animal generally unpalatable to carnivorous enemies, and, secondly, by leading to important modifications in the tail, by which its depth is increased, and its form assimilated to that of newts and other truly aquatic animals, so converting it into a powerful organ of propulsion."

The only other Myogalid that demands special notice is the single known species of the American fauna. This was formerly considered to be very nearly allied to, and even identical with, the *Urotrichus talpoides* of Japan, but is now isolated as a peculiar type, the *Neurotrichus gibbsii*. This is at once recognizable among all the American animals, by the combination of mole and shrew characters, the number of teeth (*i.* $\frac{3}{2}$, *c.* $\frac{1}{1}$, *pm.* $\frac{3}{2}$, *m.* $\frac{3}{2}$ on each side) and the conical upper incisors like those of a shrew. It has only been found in Western North America, and was originally obtained in Washington Territory. According to Mr. Lord, who found it on grassy prairies near the Fraser river, its "subterranean home is a large space or hole excavated like a small cave, and lined with bits of dry grass and leaves. From the central residence roads are tunnelled away, radiating from it like the spokes of a wheel. His tunnels are not like those of the mole; he never throws up heaps or mounds of earth to get rid of the surplus material; he digs as the mole, but makes open cuttings, at short intervals, about four or five inches long." The length of the animal is little over four inches, the head and body measuring two and a half and the tail one and six-tenths inches.

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FIG. 82. — *Myogale moschata*, desman, one-half natural size.

orbital canal is very large, and arched over only by a narrow osseous bar. The zygomatic arch is very slender, and the lower jaw has erect ascending rami, and without cavities under the coronoid processes. The sternum has a manubrium of moderate size; the scapula is provided with a metacromion process; the clavicle is elongate, the humerus sub-cylindrical, and the carpus has no sickle-shaped bone.

The family embraces five known genera, of which the Eur-Asiatic region (including Europe and Northern Asia) has four, and the North American has only one. They are mostly small animals, but the type of the family, *Myogale moschata*, ranks among the largest of the order. The species just cited has a head and body aggregating nearly eight inches in length, and the tail is almost as much more. The two species of *Myogale* are both found in Europe, but have a remarkable restriction of range; the *M. moschata* is now limited to Southeastern Russia and Western Asia. Its congener, *M. pyrenaica*, is found only in the neighborhood of the Pyrenees

mountains. But in a period immediately preceding the glacial epoch a species of *Myogale*, identified with the *M. moschata*, extended westward as far as England, its remains being found in the forest beds of that country. Both the living species are aquatic, and live in still waters, from which they make burrows, often extending as winding passages, to a considerable distance, in the direction of the surface, "towards which they always direct them, probably on account of the greater looseness of the surface soil, and the necessity of obtaining air for respiration. These burrowing habits have evidently been handed down by remote ancestors, more fossorial than natatorial in their organization." Their food, judging from the remains found in their stomachs, "consists chiefly of water-beetles, and larvæ of different kinds, and it is probable that Crustacea and other invertebrate aquatic species of animals also contribute to it." They have very elongated flexible snouts, almost reminding one of the elephant's trunk in appearance; this is brought actively into play during the search for provisions. In the words of Dallas, "it is turned and twisted in various directions, touching the various bodies that come in the way, and is used to feel about for prey, which is seized and conveyed to the neighboring mouth after the same fashion as the trunk of an elephant." It is also said of the desman that the trunk is put into its mouth, and that it then utters a "cry like a duck; when irritated or threatened, it hisses and tries to bite." The name muskrat, which is one of the popular designations of the desman, is due to the singular development of glands above the tail, which is found only in that species, the *Myogale pyrenaica* having them at most in a rudimentary condition. "These glands are undoubtedly made up of aggregated sebaceous glands, as shown by their minute structure, their position and their secretion." The office of this secretion "appears to be protection to the animal, though, according to some writers, it occasionally falls a prey to pike and other carnivorous fishes, the flesh of which becomes tainted with the powerful penetrating odor. It is interesting to notice how the development of these glands appears to have resulted in a two-fold manner to the advantage of the species; in the first place by affording a protective fluid, rendering the animal generally unpalatable to carnivorous enemies, and, secondly, by leading to important modifications in the tail, by which its depth is increased, and its form assimilated to that of newts and other truly aquatic animals, so converting it into a powerful organ of propulsion."

The only other Myogalid that demands special notice is the single known species of the American fauna. This was formerly considered to be very nearly allied to, and even identical with, the *Urotrichus talpoides* of Japan, but is now isolated as a peculiar type, the *Neurotrichus gibbsii*. This is at once recognizable among all the American animals, by the combination of mole and shrew characters, the number of teeth (*i.* $\frac{3}{2}$, *c.* $\frac{1}{2}$, *pm.* $\frac{3}{2}$, *m.* $\frac{3}{2}$ on each side) and the conical upper incisors like those of a shrew. It has only been found in Western North America, and was originally obtained in Washington Territory. According to Mr. Lord, who found it on grassy prairies near the Fraser river, its "subterranean home is a large space or hole excavated like a small cave, and lined with bits of dry grass and leaves. From the central residence roads are tunnelled away, radiating from it like the spokes of a wheel. His tunnels are not like those of the mole; he never throws up heaps or mounds of earth to get rid of the surplus material; he digs as the mole, but makes open cuttings, at short intervals, about four or five inches long." The length of the animal is little over four inches, the head and body measuring two and a half and the tail one and six-tenths inches.

The moles constitute a peculiar family named *TALPIDÆ*, which is not only well distinguished by the form of the body in conjunction with that of the feet, but whose members are extremely like each other in superficial appearance, although entirely unlike the shrews, to which they are nearly related in most respects. The different species, however, differ markedly from each other in dentition. But in all the body is

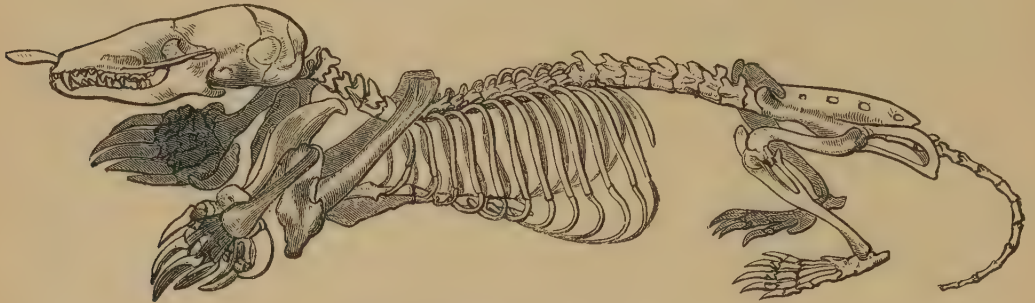


FIG. 83. — Skeleton of *Talpa europea*.

barrel-shaped, terminating in front in a produced snout, provided with wide digging paws, generally with a short tail, and with the pelage very dense and soft. The skull has no well-developed posterior ridges. The infra-orbital canal is an extensive transverse aperture arched over by a very narrow osseous bar, and a slender rod is developed to the zygomatic arch. The lower jaw has the ascending rami erect, and without cavities at the bottoms of the coronoid processes, but behind it is contracted under the ascending rami. The sternum has an elongated manubrium; the scapula is destitute



FIG. 84. — *Scalops aquaticus*, common mole of America.

of a metacromion process; the clavicle is short but broad, and the humerus broad and enlarged at its angles; the carpus is peculiar in being furnished with an enlarged sickle-shaped bone. The moles essentially agree in habits as well as in structure.

They are, as a whole, distributed throughout the entire northern hemisphere, ranging northward into Canada and Scandinavia, and southward nearly into the tropics, but in detail they exhibit noteworthy specialization; groups, characterized by trenchant peculiarities of dentition, being limited to the several geographical regions. The

Talpæ, distinguished by front upper incisors little larger than the lateral, and large upper canines, are confined to the Eur-Asiatic realm, where they are developed under four generic forms, *Talpa*, *Mogera*, *Parascaptor*, and *Scaptochirus*. The *Condyluræ*, with front upper incisors much larger than the lateral, and with a fringed muzzle, are North American, as are also the *Scalopes*, which have a dentition essentially like the *Condyluræ*, but without a fringed muzzle; the *Condyluræ* are represented by only one genus and species — the *C. cristata* — but the *Scalopes* are manifested under two generic types — *Scalops* (i. $\frac{3}{8}$, c. $\frac{1}{8}$, pm. $\frac{1}{4}$), with the common mole of the Eastern United States, *S. aquaticus*, and *Scapanus* (i. $\frac{3}{8}$, c. $\frac{1}{8}$, pm. $\frac{1}{4}$), with two species, *S. americanus*, or *breweri*, and *S. townsendi*.

The Star-nosed Mole, *Condylura cristata*, is found throughout the northern United States and Canada, from the Atlantic to the Pacific. The generic name arose from the fact that in stuffed specimens the skin of the tail sometimes shrinks, so that the bones showing through give that member a jointed appearance. This species has forty-four teeth, the snout very long, and terminated by a circle of about twenty



FIG. 85. — *Condylura cristata*, star-nosed mole.

cartilaginous rays, in the centre of which are the nostrils. In color the star-nosed mole is of a dark blackish gray, and the fur is very soft. In its habits this form closely resembles the true moles, living like them in underground burrows, which, however, are not constructed on such an elaborate plan as are those of *Talpa europea*.

The American moles are not as notable as the European, either on account of damages committed or for complexity of architecture, although the latter remains to be investigated.

The common English mole — *Talpa europea* — has been the subject of much investigation by various naturalists, and several volumes even have been devoted to the consideration of its habits, and the means of checking the damages which it commits in gardens, as well as fields. One of the most industrious and successful of its students and historians was Henri Le Court, a French investigator of the closing years of the last and the commencement of the present century, whose results were edited by Cadet de Vaux in a special work published in 1803. We cannot do better than present the results of these investigations, as summarized by Bell in his history of British quadrupeds. "The district or domain to which an individual mole confines itself may be termed its encampment. Within its limits, or at least in immediate communication with

this district, all the labors of the animal are pursued. It consists of the habitation or fortress, from which extends the high road by which the animal reaches the opposite extremity of the encampment, and of various galleries or excavations opening into this road, which it is continually extending in search of food, and which constitute, in fact, its hunting-ground. The fortress is formed under a large hillock, which is always raised in a situation of safety and protection, either under a bank, against the foundation of a wall, at a root of a tree, or in some similar locality. The earth, of which the dome covering this curious habitation is composed, is rendered exceedingly strong and solid, by being pressed and beaten by the mole in forming it. It contains a circular gallery within the base, which communicates with a smaller one above by five nearly equidistant passages; and the domicile or chamber is placed within the lower and beneath the upper circular gallery, to which last it has access by three similar passages. From the chamber extends another road, the direction of which is at first downwards



FIG. 86. — *Talpa europea*, European mole, one-half natural size.

for several inches; it then rises again to open into the high road of the encampment. From the external circular gallery open about nine other passages, the orifices of which are never formed opposite to those which connect the outer with the inner and upper gallery; these extend to a greater or less distance, and, according to De Vaux, return, each taking an irregular semicircular route, and opening into the high road at various distances from the fortress. Such is a very hasty description of this most singular structure; and nothing surely can be imagined more admirably calculated to ensure the security or the retreat of the inhabitant, than such an arrangement of internal routes of communication as this. The chamber communicating beneath directly with the road, and above with the upper gallery, — this with the lower by five passages, and the latter again with the road by no less than nine, — exhibit altogether a complication of architecture which may rival the most celebrated erections of the beaver.

“Another very important part of the encampment is the high road, which has been termed by the continental naturalists ‘the passage’ — a name which affords no distinctive idea of its nature or use. It differs essentially from all the other routes and

excavations, both in its construction and use. It extends from the fortress to the extremity of the domain in nearly a direct line, forming in fact the main route of communication between the fortress and the different parts of the encampment; and the alleys which lead to the hunting-ground, or quarries, open into it on each side. Its circumference is larger than the body of the mole, though not large enough to admit of two individuals passing each other. The walls are beaten by the frequent pressure of the animals' sides against them, until they become very smooth and compact: in fact, this road is principally formed by the compression of the earth which surrounds it, rather than by actual excavation; and hence the infrequency of mole-hills over it, compared with the number which are observed in connection with the alleys and the quarries, in forming which the earth is moved out of the way by being thrown up on the surface. In some instances the same mole forms a second and even a third road; but this is generally done in order to extend its operations to a new and more productive district. In other cases, many moles are known to employ one road, though they never intrude upon each other's hunting-ground: in this case, should two of them meet, one must retreat into the nearest alley, or a battle ensues, which proves fatal to the weaker of the combatants. The road is formed at a greater or less depth from the surface, according to the nature of the soil, the danger of injury from superincumbent pressure, and other circumstances. Thus, in safe situations, where there is nothing to disturb or threaten the security of its roof, it will be found at a depth of about four or five inches; whilst in other places, as under a road or beneath a stream, the earth is left not less than a foot or a foot and a half deep above it.

"As it is only on the high road that the mole can visit the different quarries or hunting grounds of its domain, it is traversed regularly several times in the course of the day; hence it is only in this route that it can with any certainty be taken, and the traps are therefore always placed in its course by skilful mole-catchers, so as to intercept the animal in its journey between the fortress and that alley which may at the time happen to be the seat of its labors.

"The swiftness with which the mole will traverse its domain by means of this principal road, was made the subject of an amusing and satisfactory experiment by Le Court. Having ascertained the exact direction of the road, and finding that the mole was engaged in exploring for its food the ground at the farthest extremity from the fortress, he placed along its course, at certain distances, several pieces of straw, one extremity of which penetrated within the passage, and to the other end was fixed a little flag of paper. He also introduced into the passage near the end a horn, with the mouth-piece standing out of the ground. Then waiting till he was sure of the mole's presence at that part of the road, he blew into the horn, to use the words of Geoffroy, '*un cri effroyable*'; when, in a moment, the little flags were successively thrown off, as the mole, in its rapid course towards its fortress, came in contact with the interior extremities of the straws, and the spectators of this neat and demonstrative experiment affirm that the speed of the frightened mole was equal to that of a horse at full trot.

"The alleys or galleries are opened from the sides of the road, and generally incline a little downward from their origin towards their termination. We have already stated that the mole forms the alleys by the expulsion of the earth; whilst the passage or high road is formed principally by its consolidation. When an alley is opened, if a plentiful supply of food be found, the mole proceeds to form various ramifications from its extremity, throwing up fresh mole-hills as it advances in its search after its

prey ; but if the situation prove but sterile, another alley is opened at a different part of the road. These excavations are more or less deep, according to the nature of the soil, and the degree of humidity, — circumstances which regulate the situation in which the earth-worms most abound. In forming its runs, or excavating its quarries, it pushes the loosened earth before it till it arrives at the last formed hillock or mole-hill ; and when this becomes too distant, it makes its way to the surface through the solid earth, forming a new shaft over which another hillock is gradually made by the successive portions of earth which are brought from the scene of its mining operations.

“But the labors of the mole are not confined to the excavations already mentioned. In lands newly sown in summer with barley or turnips, the surface of which is consequently light and yielding, after moderate rain, which has brought the earth-worms to the surface, the mole follows them, and pursues its chase along the superficial layer of the soil, digging a shallow continuous trench, in which work it advances with great rapidity. This is done by merely forcing its way through the light soil, and thus lifting it up ; and mole-catchers take advantage of these times to steal softly upon them, and throw them out of the ground with their paddle. But great quickness is necessary in doing this, for the mole will bury itself again so rapidly as often to escape, even when fairly thrown on to the surface. We have on more than one occasion seen a mole making so shallow a run, that the fine soil has fallen away on each side, leaving the creature’s back exposed to view. It is said that the gravid female, to whom the usual excavations in the subterranean alleys would be too laborious, limits herself principally to this lighter toil.”

SUB-ORDER II. — DERMOPTERA.

The flying, or rather skimming insectivores have the members modified for partial flight or progression in the air, the limbs being elongated and slender and connected by an extension of the skin ; the lower jaw has the condylar portions flaring outward, and the incisor teeth of the lower jaw are palmate and pectinated, and those of the upper, as well as the anterior molars of both, are more or less conical. Only one family, and indeed not certainly more than one species of this group is known.

This family of *GALEOPTHECIDÆ*, in more detail, exhibits the following additional peculiarities : — It has a membrane connecting the anterior and posterior feet, extending as far as the digits ; and behind, an interfemoral membrane embracing a portion of the tail, and also extending to the innermost digits ; and even in front there is an incipient membrane on each side of the inner faces of the limbs. There are five toes to each of the feet, and the claws are arched and compressed. The head is somewhat fox-like, and the ears rather short. But the chief peculiarity is in the dentition. There are sixteen teeth in the upper jaw and eighteen in the lower. The incisors in the lower jaw are six, four have broad, compressed, and very deeply digitated crowns, and attenuated roots, while the two lateral ones (one on each side) are more distant and less specialized in form ; the incisors in the upper jaw are four in number, and those of the respective sides are widely separated. The so-called canines have double roots and wide crowns, and resemble the premolars, which, with the molars, are five in number, and have severally three roots and three to five cusps. The teats are on the sides of the breast near the axils.

There are at most two species of this singular type, and even these are doubtfully distinguished. The common if not only species is the Colugo or *Galeopthecus volans*,

which is found in Sumatra, Borneo, and Malacca. It is an arboreal animal, and passes from one tree to another with ease by means of its extended membranes, but it is not a true animal of flight like the bat, although much more entitled to be called a flying animal than the flying-squirrels or Anomalures. Mr. Wallace, who had the opportunity of observing its movements in a state of nature, says, "Once, in a bright twilight, I saw one of these animals run up a trunk in a rather open place, and then glide obliquely through the air to another tree, on which it alighted near its base and immediately began to ascend. I paced the distance from the one tree to the other and found it to be seventy yards, and the amount of descent I estimated at not more than thirty-five or forty feet, or less than one in five. This, I think, proves the animal must have some



FIG. 87. — *Galeopithecus volans*, colugo, kaguan, one-fifth natural size.

power of guiding itself through the air, otherwise in so long a distance it would have little chance of alighting exactly upon the trunk." The power of thus guiding itself Mr. Wallace refers to the tail, and he suggests that it may rise over obstacles in its course "by the elevatory action of that organ."

The colugo appears to shun the bright daylight, and to be most active during the hours of twilight and early dawn. It is at any rate said to be quite sluggish during the day, and to be found rarely moving, but generally clinging to trees; if disturbed it will run slowly up by means of its feet.

The exact dietetic habits of the colugo are imperfectly known. According to Wallace, like the cuscus of the Moluccas, it feeds chiefly on leaves, but it is claimed also

to at least supplement its food with insects. That there is something peculiar in its food or manner of feeding is indicated by the strange dentition, but what are those peculiarities remains to be decided by observation. The contents of the stomach have not even been examined to a sufficient extent to guide us in an opinion.

A summary of the families now described may be of service. Mr. Alfred R. Wallace, and following him, Mr. W. S. Dallas, estimate the total number of species of Insectivora at one hundred and thirty-five, and of these about sixty-five, or nearly one half, belong to the single family of shrews. The most recent statistics, however, add largely to this total, and reverse the relative proportions. Accepting the data exhibited by Dr. Dobson and by Dr. Trouessart, two hundred and eight existing species of insectivores are known, and one hundred and twenty-six of these are soricids. It is possible that when the soricids have been more critically studied their number may be materially reduced.

The extinct insectivores already described are numerous, but as many are known only from fragmentary skeletons, it is not certain that all of the forms referred to the order really belong to it. Professor Cope has recently proposed a classification of the order which takes into consideration both the recent and extinct forms, but it is of too technical a character for insertion here. Seven extinct groups of family rank are known. Most of these fossil forms are of tertiary age, and the Territory of Wyoming has furnished a large proportion of them.

The Talpidæ date back to eocene times, one genus occurring in the French rocks of that age, and another, *Talparus*, in the rich beds of Wyoming. Allies of *Gymnura* also occur in the eocene of France. In the miocene we find representatives of the Myogalidæ and Erinaceidæ, a fossil hedgehog belonging to the same genus as the living forms, occurring in the strata of France. In the same rocks also occur shrews much like the recent species. These forms all belong to the dilambdodont series; but if Professor Cope is correct in his views concerning the fossil families, the zalambdodont type predominated in the early tertiaries. Our knowledge is as yet too slight to warrant any generalizations upon the probable phylogeny of the various groups.

THEODORE GILL.

ORDER IV. — CHIROPTERA.

Next to the insectivorous mammals, and probably derivatives from the same common stock with them, are the Bats, constituting the order Chiroptera. These may be defined, in contrast with the insectivores, as mammals with the anterior limbs modified for flight by the elongation of the forearm, and the still greater development of four of the fingers, all of which are connected together by a membrane, which likewise extends to the hind feet. The bones of the forearm are united, and the ulna is reduced to a rudiment. The hind limbs are so rotated that the knee bends backward; they are otherwise comparatively little modified, but they, as well as the forelimbs, are entirely free from the body, as far as their proximal segments are concerned, as in the Primates, but contrary to what prevails in most mammals, in which those segments (the arm and the leg) are included in the common integument of the body. A special cartilaginous element, named the calcar, is generally developed, originating from the ankle joint at its inner side, and is directed inward; its object is to support the inter-femoral membrane, which more or less envelops the tail, and extends between the hinder limbs. The teeth are encased in enamel, and of three kinds, molars, canines, and incisors, and are also developed in two sets, milk and permanent. The lower jaw has well developed condyles, which are received in special sockets. The placenta is discoidal and deciduate.

The species exemplifying these characters are very numerous, about four hundred being recognized by the latest monographer, Dr. George E. Dobson, to whom we are indebted for most of our information respecting the group. The terse English term, Bat, is applied to all the representatives of the order (although not exclusively), but in many languages the common name bears some relation to the supposed resemblance of the form to other animals: for example, among the Germans, the equivalent of Bat is Fledermaus, or the flitter mouse, and among the French, it is Chauve-souris, which also indicates a relationship to the mice. The common English term, however, has not always been so generally in use, for our early English ancestors used the close equivalent of the present German name, flitter-mouse, as well as rere-mouse. The meaning of the older term, flitter-mouse, is practically the flying, or flittering mouse. The generality of the current word, Bat, may be subject, however, to a proviso, for although no other name may ever be heard in America, and rarely in England, for these animals, it is said that in some parts of the latter country flinty-mouse, evidently a corruption of flitter-mouse, is still in use. Among the places where such is said to be the case are parts of Hampshire, including Selborne, and of Kent.

Although among the most specialized and aberrant of mammals, and numerous in species, as well as the more comprehensive groups, at the same time the order is one of the most natural and compact in the animal kingdom, and according to the leading student of the group, "of all the orders of mammals none are so well-defined as the Chiroptera: the presence of true wings at once distinguishes them; and this peculiarity is accompanied by other modifications of bodily structure having relation to aerial locomotion. Thus, in direct contrast to all other animals (in which locomotion is chiefly effected by action from behind, and the hind limbs accordingly preponderate in size), in the Chiroptera the fore limbs, being the only agents in propelling the body

forward during flight, immensely exceed the short and weak hind extremities; the thorax, giving origin to the great muscles which sustain flight, and containing proportionately very large lungs and heart, is remarkably capacious, and the ribs are flattened and close together; the shoulder-girdle also is greatly developed in comparison with the weak pelvic bones. Other structural modifications secondary to these are observable in the form of the bony skeleton, in the integumentary system, in the alimentary canal, and in other parts of the body."

The peculiar appearance of the Bat, and its relations to its surroundings, have caused it to be looked upon as a weird and uncanny animal: making its appearance at dusk, flitting about in the night in noiseless flight, suddenly met and unannounced, it has engendered superstition among the vulgar and also given birth to strange conceptions in art. It was one of the unclean animals of the Jews: it was consecrated by the ancient Greeks to Proserpine, and the witches were wont to employ it in their mystic potions. The evil spirits are represented in painting with bat-like wings, and thus contrasted with the spirits of light, to whom the wings of birds are attributed. "To the fancy of the ancients," says Dr. Harrison Allen, "of placing the wings of a bat upon demons, is happily opposed the sweet conceit of the poets in adorning the spirits of angels and cherubim with the wings of birds. The wing of the bat is sombre and angular; that of the bird is of delicate hues and replete with curves. It is, therefore, poetic justice to have the one become the emblem of the infernal as the other is the expression of the heavenly form."

But the bats are not always regarded as unwelcome intruders, and of evil omen. The Rev. Hilderic Friend, of London, remarks that "while the bat has long been regarded by us as foreboding misery and death to the inmates of the house where it entered, the Chinese look upon it as one of the most auspicious of creatures. Shortly after my marriage, we were one night very much startled at the loud squeaking of some strange visitor, and, on looking up, found that a bat which had come to make a call, having fixed itself firmly to the mosquito curtain, was flapping its wings and making a most hideous noise. We managed at last to drive it away, and were much comforted in the morning when the native Chinese servants informed us that it was a most happy omen. In Samoa one species of bat is a great pet of the inhabitants of that group of islands."

However the bat's wings may appear to the poet and artist, they are very efficient for the animal itself. The adaptation for flight is quite peculiar; the other so-called flying mammals — the flying squirrels and the anomalures — are not really entitled to the name, for in them merely a membranous extension of the skin between the members exists, which serves rather to deaden their fall than enable them to fly at will. Even the colugo cannot be compared, as a flying animal, with the bats. The name Chiroptera (*cheiros*, hand, and *pteron*, wing) well expresses the mode of adaptation for volant exercise, for, as already indicated, the main part of the wing is constituted by the hand, whose fingers are excessively elongated, and the membrane connecting them as well as extending to the hind limbs is extremely thin, and supplied with nerves which render it very sensitive and enables the animal to direct its course even when blinded.

A noteworthy feature in the physiology of the bats is the development of glands, which may occur in different regions, and which are chiefly developed in the male. These are supposed to be odoriferous, and are especially found in the more specialized forms of the animalivorous group.

The function of these glands, it is supposed by Dr. Dobson, is to act principally by its odoriferous secretions "in bringing the sexes together in the dark retreats where they hide, as they are always found most abundant during the rutting-season; but in the large species of Megachiroptera, as in *Pteropus*, which roost in trees, exposed to the attacks of passing animals, and in which they are always developed in the female, but to a less extent, the strong musky odor exhaled, which fills the air in the neighborhood of the haunts, is evidently protective."

The number of young and the mode in which those young are nourished are determined or limited by the habits of the animal. Only two young are born together, but in many cases not more than one is brought up, and Dr. Dobson remarks that he never found a mother with more than one clinging to her body. It is believed, however, that the male frequently assumes not only the duties of paternity but of feeding the young. The teats have been found highly developed in the males of a number of species, and Dr. Dobson remarks that the size of the pectoral teats in many male specimens led him to think that instances of the male performing the office of nurse are probably not uncommon among bats. But whatever may be the truth respecting the assumption of such an office, it is not doubtful that he does attend to his mate and young with considerable assiduity, and he is said at times to place himself in front of the mother, so that the young may be equally protected and warmed by both parents at the same time.

The males are sometimes especially adapted for carrying the young, as in the case, for example, of the *Chiromes torquatus*, of the oriental region, which has a nursing pouch developed as in the female, so that when two young are born together the male may relieve the female of the charge of one of them. Dr. Dobson has shown also that other bats, such as the frugivorous species *Cynonycteris grandidieri* and *Cynopterus marginatus*, have likewise special adaptation for carrying the young.

The bats are sociable and gregarious, but the two sexes do not, as a rule, intermingle, and only come together at the nuptial season. At other times they live apart, and sometimes at considerable distances, so that in a large colony of a given species not a single individual of the female sex may be found, while in another the females will abound and not a male occur.

Although the bats in external appearance and adaptation to flight so closely resemble each other, they are nevertheless distinguished by salient differences among themselves, even with reference to those characters which were formerly used to distinguish orders: for example, on account of differences of dentition, Linnæus referred the species thereof to two of his orders: the typical Noctilionids were associated with the rodents on account of the enlarged incisors, while most of the species were relegated to the primates on account of the pectoral position of the mammæ. They also differ very much in the nature of their food and the adaptation to its ingestion and digestion. In taking a preliminary survey of all the forms, however, it will soon become obvious that they may be differentiated into two primary groups, one of which is distinguished by smooth, longitudinally furrowed molar teeth, and the other by acutely tubercular or transversely ridged molars. These characters are co-ordinated with many others. The two groups are now universally considered as sub-orders of Chiroptera; those with the longitudinally furrowed and smooth molars being called generally Frugivora, or Megachiroptera, and those with the acutely tubercular molars being distinguished as Animalivora, Insectivora, or Microchiroptera.

SUB-ORDER I. — FRUGIVORA.

The fruit-eating bats have the molar teeth smooth, but marked with a longitudinal furrow; the bony palate is continued behind the last molar and slowly furrowed downwards; the index finger generally terminates in a claw, and the second finger has three joints; the sides of the ear conch form a complete ring at the base.

The Frugivora do not manifest much diversity of structure, and all the forms which exhibit the peculiarities of structure just indicated may be combined in a single natural family, the PTEROPODINÆ. The ears of these have no tragus; the nostrils are simple and at the summit of the snout; the wings are broadly expanded, and the second finger almost always has a claw at its end; the teeth are variable in number (*i.* $\frac{3}{1}$ – $\frac{3}{0}$; *c.* $\frac{1}{1}$; *pm.* $\frac{3}{1}$ – $\frac{3}{2}$; *m.* $\frac{2}{1}$ – $\frac{1}{1}$) as well as size; a tail is generally present, but it is sometimes entirely absent.

This group is entirely confined to the tropical regions of the old world, where it is represented by about seventy species. Some of these have a tongue of moderate size, and the molars are well developed: these constitute a sub-family, Pteropodinæ. Others have a tongue very elongated and the molars are much reduced, being both narrow and but slightly raised above the gum; such are the Macroglossinæ. The Pteropodinæ includes most of the species, only four being known of the Macroglossinæ, although each of those four represents a distinct genus. The genus *Pteropus*, the typical one of the family, is also by far the most numerous, forty-one species and six sub-species being admitted by Dr. Dobson in his monograph. The habits of the various species are little different, and that which may be said of one is for the most part applicable to all. Wherever fruit is abundant through the Indian peninsula south of the Punjab, says Dr. Dobson, the *Pteropus medius*, the flying-fox of Europeans, is to be found. "A colony, consisting of many hundreds of individuals, is often found inhabiting a single tree, which is so covered that the animals, hanging head downward, wrapped up in their wings, resemble large dark-colored leaves. I have often been able to detect their presence on trees at night by the strong musky odor evolved from their bodies, which fills the motionless air, and which is probably due to the secretions of the shoulder glands. Mr. Francis Day, who has had the opportunity of observing the habits of this species for many years, remarks: 'In their diet they are exclusively frugivorous; and they do very great injury to cocoanut plantations and mangoe gardens. Their habits are very intemperate, and they often pass the night drinking the toddy from the chatties of the cocoanut trees, which results either in their returning home in the early morning in a state of extreme and riotous intoxication, or in being found next day at the foot of the trees sleeping off the effects of their midnight debauch.'" This paragraph may be recommended to the intemperate advocates of temperance, who have so often asserted that animals cannot be induced to drink of intoxicating liquor. Man is no more peculiar in the possession of a depraved appetite than in other respects. According to Dr. Day, also, "the wild almond (*Terminalia catappa*), when in fruit, is one of their favorite resorts at night-time; they sometimes carry off the almonds into the verandahs of houses, where they extract the kernels, and in so doing frighten nervous people into the belief that robbers are endeavoring to effect an entrance. They are also very partial to wild-figs."

Another interesting type is the genus *Cynopterus*, the species of which have a distinct tail; the fur of the nape and shoulders is not differentiated from that of the back,



Pteropus edwardsi, flying-fox.

and there are only two true molars. This includes smaller species than *Pteropus*, and only seven of the genus are known. One, *C. marginatus*, is quite common throughout India and the neighboring islands. The head and body together measure less than four and one-half inches, but it is regarded as being one of the greatest pests of the country on account of the ravages which it commits on fruit, and especially pears, guavas, and bananas. It is said (but the data for the assertion are not given) that on the plains they will travel as many as thirty to forty miles to and the same from distant feeding grounds in the course of a single night on a foraging excursion. This statement, however, may well be doubted. Dr. Dobson tells an almost incredible story of their voracity. A specimen which came into his hands at Calcutta was given "a ripe banana, which, with the skin removed, weighed exactly two ounces. The animal immediately, as if famished with hunger, fell upon the fruit, seizing it between the thumbs and the index fingers, and took large mouthfuls out of it, opening the mouth to the fullest extent, with extreme voracity. In the space of three hours the whole fruit was consumed. The next morning the bat was killed, and found to weigh one ounce, half the weight of food eaten in three hours. Indeed, the animal while eating seemed to be a kind of living mill, the food passing from it almost as fast as devoured and apparently unaltered, the eating being performed alone for the pleasure of eating. This will give some idea of the amount of destruction these bats are capable of producing among ripe fruits."

Several very remarkable modifications of structure are exemplified in other forms of the Pteropodids. One of the most extraordinary is exhibited in the genus *Hypsignathus* of Dr. Allen, or, as it has well been called by Mr. A. Murray, *Sphyrocephalus*. Both names are indicative of the features of the animal, the name *Hypsignathus* alluding to the high or deep jaws, and *Sphyrocephalus* to the hammer-like head: the head becomes higher toward the snout on account of the great depth of the upper jaw, and the muzzle in front has very prominent foliaceous cutaneous expansions. The only species, *H. monstrosus*, is an inhabitant of Western tropical Africa, and was first made known in 1861, by the eminent American naturalist, Dr. Harrison Allen, from specimens obtained by DuChaillu.

SUB-ORDER II. — ANIMALIVORA.

All the remaining Bats, including by far the largest portion of the order, form another group which has been named Animalivora, Insectivora, or Microchiroptera. The two former names, as will be seen, contrast with Frugivora, and allude to the diet,—animal food, or especially insect food,—while the last is given in allusion to the smaller size of most of the representatives of the group. Neither diet nor size, however, are absolutely distinctive; although it is true that most of the species are smaller than most of the Frugivora, the largest species of the present group exceeding in size the smallest of the former. Nor are they at all so restricted as to food as would seem to be indicated by the names in question. Most of them, indeed, are mainly dependent on insect life for their subsistence, but, probably, it is to a considerable extent due to their small size that they thus satisfy themselves with such objects. Some larger forms are eminently carnivorous, and such is the case with the typical Megadermids and certain Phyllostomids, but some other forms of even the same family of Phyllostomids are, to a very large extent, and even mainly, devoted to fruit, as in the case of the genera *Artibeus* and *Stenoderma*. A few besides have a very special-

ized, modified diet, as the Desmodontids, which derive their food by the suction of the blood of larger animals. The Animalivora have the molar teeth acutely tubercular, the bony palate variously developed, the index finger clawless, the second finger single-jointed (rarely with two joints), and the sides of the ear disconnected at the base.

We first come to a group, RHINOLOPHIDÆ, peculiar to the old world, which are distinguished by a leaf-like extension of the skin around the nostrils. The hair is of the regular vespertilionine type; the ears are large and destitute of tragi; the muzzle has extensive cutaneous appendages forming a leaf, and in the midst of this the nostrils are sunk. The wings are wide, the middle finger has two phalanges, and the index finger is imperfect and destitute of a phalanx. A moderate tail exists, and is contained within an interfemoral membrane. The teeth are never more than thirty-two in number; the number of premolars varies from one to three in the upper jaw, and two to three in the lower; the upper incisors are very much reduced, and placed at the extremities of the slender premaxillary bones.

This family is divided into two sub-families, Rhinolophinæ, with a single genus, and the Phyllorhininæ, with five genera. The Rhinolophinæ have unequal toes, the first having two, and the others three joints each. But one genus is known, — *Rhinolophus*. The Phyllorhininæ have equal toes with two phalanges each. Four genera are recognized by Dr. Dobson, — *Tricenops*, *Rhinonycteris*, *Phyllorhina* and *Cœlops*. *Rhinolophus* is represented by two species in England and other parts of Europe. The English name is Horseshoe Bat, a designation given in allusion to the horseshoe form of the nasal leaf. The two species, *R. ferrum-equinum* and *R. hipposideros*, appear to be not rare in southern Britain. The former has an expansive wing of fourteen or fifteen inches. According to Bell, "Montagu found it in considerable numbers, in company with the smaller horseshoe bat, in the well-known cavern near Torquay called Kent's hole, a retreat so dark and gloomy that no other species even of this lucifugal family were found to frequent it. The French naturalists equally record the retreat of this species to be chosen in the darkest and least accessible caverns, in abandoned quarries, and other subterranean excavations." It is said to chiefly feed upon beetles or chafers, and to limit itself simply to the bodies of these. It is not likely, however, that it is so exclusive in its diet.

The only other specially noteworthy species of the family is the *Phyllorhina armigera*, which occurs in many parts of India and extends into China. This is a Phyllorhine bat, which has the horizontal anterior nose-leaf horseshoe-shaped, and the centre thereof uncovered. The head and body together are about four inches long, and the tail about half as long.

A special family has been established by Dr. Dobson under the name Nycteridæ, but which is mostly equivalent to the family MEGADERMIDÆ previously introduced. This family has only two genera, but these are so distinct from each other that they have been regarded as representatives of distinct sub-families by Dr. Dobson. In all the hair is of the vespertilionine type; the ears are large, and have well-developed tragi; the muzzle has distinct cutaneous appendages margining the apertures of the nostrils; the wings have two joints to the middle finger; the index finger sometimes has, and sometimes is destitute of, a joint; the tail is variable; the premaxillary bones are cartilaginous or small; the upper incisors are either altogether absent or very small; and the molars are well developed, and have acute W-shaped cusps. The

sub-families are easily distinguishable. The *Megaderminæ* have nostrils which are concealed by the base of an erect cutaneous process at the bottom of a cavity near the extremity of the muzzle; the tail is very short, and in the base of the large, interfemoral membrane. The *Nycterinæ* have nostrils at the anterior extremity of a deep, longitudinal, facial groove; and the tail is long and produced to the hinder margin of the interfemoral membrane.

The genus *Megaderma* is found in Africa as well as the Indian region, and one of its species extends into Australia. The four species known are very distinct from each other, and have been separated even into distinct genera or sub-genera. The characteristic and most common species of India is the *Megaderma lyra*, which has two pairs of premolars in both jaws, and a nose leaf whose central longitudinal crest has a circular base. The head and body together measure somewhat over three inches. An interesting account of some observations on its habits has been given by Mr. Blyth.



FIG. 88.—
Ear of bat.
t. Tragus.

“Chancing one evening to observe a rather large bat enter an outhouse from which there was no other egress than by the doorway, I was fortunate in being able to procure a light, and thus to proceed to the capture of the animal. Upon finding itself pursued it took three or four turns around the apartment, when down dropped what I at the moment supposed to be its young, and which I deposited in my handkerchief. After a somewhat tedious chase I secured the object of my pursuit, which proved to be a fine female of *Megaderma lyra*. I then looked to the other bat which I had picked up, and, to my considerable surprise, found it to be a small *Vespertilio*, nearly allied to the *Pipistrelle* of Europe, which is exceedingly abundant, not only here but apparently throughout India. The individual now referred to was feeble from loss of blood, which it was evident the *Megaderma* had been sucking from a large and still bleeding wound under and behind the ear; and the very obviously suctorial form of the mouth of the Vampire was of itself sufficient to hint the strong probability of such being the case. During the very short time that had elapsed before I entered the outhouse, it did not appear that the depredator had once alighted; and I am satisfied that it sucked the vital fluid from its victim as it flew, having probably seized it on the wing, and that it was seeking a quiet nook where it might devour the body at leisure. I kept both animals separate till next morning, when, procuring a convenient cage, I first put in the *Megaderma*, and after observing it for some time I placed the other bat with it. No sooner was the latter perceived than the other fastened upon it with the ferocity of a tiger, again seizing it behind the ear, and made several efforts to fly off with it; but finding it must needs stay within the precincts of the cage it soon hung by the hind legs to one side of its prison, and after sucking its victim till no more blood was left, commenced devouring it, and soon left nothing but the head and some portions of the limbs.”

By far the most extensive of the families of bats, as well as the one which is most generally distributed, is the *VESPERTILIONIDÆ*. The hair is beset with spine-like scales which are imbricated, and the tips, which do not terminate in acute projections, are arranged in a spiral line. The ears are large and sometimes huge, but generally separated, and the tragi are well developed; the muzzle has no leaf-like appendage, and the nostrils open by simple crescentic or circular apertures at its extremity; the wings are moderately developed, and the middle finger has two joints. The hind limbs are rather short; the tail is more or less elongated, and contained in and produced

to the hinder margin of the large interfemoral membrane. The dentition varies in the different forms; the incisors range from two to four above and from four to six below, and the premolars from one to three upper and two to four lower. The upper incisors are small and separated by a wide space in the centre, those of the respective sides being approximated to the canines. The molars have acute W-shaped cusps. Sixteen genera, with numerous sub-genera, are arranged by Dr. Dobson in the family of Vespertilionidæ, and are segregated by him under three groups,—the Plecoti, Vespertiliones, and Miniopteri. All the temperate North American bats, except two species, belong to this family.



FIG. 89. — Vespertilionine type of bat hair.

Fourteen species of the family are accredited to the United States, and these represent six distinct genera, which have been divided into two "groups"—the Vespertiliones, with the genera *Vespertilio*, *Vesperugo*, *Nycticejus*, and *Atalapha*, and the Plecoti with *Plecotus* and *Antrozous*.

The Vespertiliones have simple nostrils whose apertures are at the extremity of the muzzle; ears of moderate size, or not very large; and an ungrooved forehead.

The typical genus, *Vespertilio*, is represented in the United States by four closely related species. In this genus the outer margin of the ear-conch commences abruptly nearly opposite the base of the inner margin of the tragus; the ears are generally equal to or exceed the head in length; and the tragi are long, narrow, and straight, or curved outwards; the muzzle is narrow, and hairy in front, and the upper premolars are generally three in number, the first being of goodly size. Four species inhabit the United States. The *Vespertilio subulatus* is the ordinary Eastern American species, and does not occur west of the Rocky Mountains. Almost equally common, in some places still more so, is the *Vespertilio lucifugus*, which has also a more extensive range, and is found on the Pacific Coast. The *Vespertilio nitidus* is an extreme western species found in California and Texas, and the *Vespertilio evotis* is also a Pacific Coast species occurring in California and Oregon.

All the other Vespertiliones of the United States have the origin of the outer margin of the external ear near the angle of the mouth; the ears are shorter than the head, and their tragi are straight or curved inwards; the muzzle is nearly naked in front of the eyes and has glandular prominences, and the upper premolars are at most two, and the first of these is either absent or minute.

The genus *Vesperugo* has four American species. In all the premaxillary bones are ordinarily developed, the upper incisors are separated from the canines and the inner bifid by a space. The *V. serotinus* has one premolar in the upper jaw; the *V. hesperus* and *V. georgianus* two; all three have two pairs of lower premolars, while the *V. noctivagans* has three pairs of premolars in the lower jaw.

The *V. serotinus* is the only species of the family alleged to be common to the United States and Europe, it being, according to Dr. Dobson, distinguishable from the common long-eared bat of England only "in being smaller"; but it has, nevertheless, been regarded as a distinct variety, and, until Dobson's investigations, was considered to be an entirely distinct species. Two forms have even been described under the names *V. carolinensis* and *V. fuscus*. In England the Serotine or long-eared bat is notable for its late appearance in the spring after its sound and long-continued slumber. According to British authors, "it flies from evening till morning, when the state of the atmosphere is favorable. In France, where it is far from being rare, it frequents forests, where it flies among lofty trees. It is also commonly found among the huge

piles of wood in the timber-yards of Paris, seeking its place of rest on the tops of the highest piles." Of the American representatives of this species no exact observations have been recorded.

The *Nycticejus crepuscularis* has the premaxillary bones very narrow and slender; the upper incisors are unicuspidate and close to the canines, and the interfemoral membrane is nearly naked. It is a common species throughout the United States, and is generally about two inches long from the tip of the nose to the base of the tail, while the tail measures somewhat less than one and one-half inches.

The *Atalapha noveboracensis*, *Atalapha cinerea*, and *Atalapha intermedia* agree in most respects with *Nycticejus crepuscularis*, but the interfemoral membrane is more or less covered with hair and the tragus is curved inwards. The *Atalapha noveboracensis* and *Atalapha cinerea* have two pairs of premolars above, and the whole upper surface of the interfemoral membrane is clothed with hair, while the *Atalapha cinerea* has only one pair of premolars in the upper jaw, and the posterior half or third of the interfemoral membrane is naked.



FIG. 90. — *Atalapha noveboracensis*, red bat, New York bat.

The *Atalapha noveboracensis*, or Red Bat, is perhaps the most common of the eastern American bats, and, according to Coues, is "rivalled in these respects by the little brown bat alone. It would be safe to say that in any given instance of a bat entering our rooms in the evening, the chances are a hundred to one of its being one or the other of these two species;" it is "an erratic yet busy little hunter for insects, out on the fly after bugs attracted to our apartments," but not itself attracted by the light as are the insects. It is readily recognizable by its red color and furry interfemoral membrane. The writer of this chapter is indebted to Mr. Frederick W. True for an account of some of the habits of the species (*Atalapha noveboracensis*) observed in Washington.

"The red bat is frequently brought to the National Museum alive. It is quite pugnacious, and when aroused will show its teeth and utter a shrill clicking sound. If its feet are detached from their support when hanging head downward, after fluttering about it is frequently content to stand upright for a short time, with its wings close and parallel to the sides of the body, and its feet widely spread, or *vice versa*. Even then it hangs down its head. If tormented for some time it will finally give up the contest and 'play 'possum' by lying quietly on its back. There is a curious movement of the eyes to be observed in the red bat, and one which is probably common to other species as well. If examined by a bright light in the evening the bat, to use the ordinary expression, closes its eyes. But in reality it is not so. The lids are not

brought entirely together, and a narrow band of the little bright eye is constantly visible. Touch the bat now gently. The eyelids open and the eye pops out suddenly as if it would escape from its socket. It does not merely look out on the external world from its cell, but pushes itself outward so that about half its circumference is external to the skin. When all is quiet once more the eye is quickly drawn in again and the lids close toward each other. The red bat does not seem to be disturbed by whistling or the ringing of bells, but the least jarring of its cage arouses it at once. One would surmise that its skin is more sensitive than its ears. When quietly resting its heart beats at an average rate of about one hundred and thirty pulsations per minute, but when disturbed the rapidity increases greatly. I have tried to estimate the rate of flight of the red bat by allowing it to fly around a room and calculating the space passed over in a minute. My observations would lead me to believe that the flight is slow, not exceeding eight or nine miles per hour. It can alter the direction of its flight, however, very suddenly, and with much grace. The species seems to be very common along the Atlantic coast, and falls into the hands of nearly every amateur collector."

A touching instance of the female's devotion to her young has been recorded by the veteran naturalist, Mr. Titian Peale, in a communication to Godman's "American Natural History," published in 1826 to 1828. In Mr. Peale's own words: "In June, 1823, the son of Mr. Gillespie, the keeper of the City Square [of Philadelphia], caught a young red bat, which he took home with him. Three hours afterwards, in the evening, as he was conveying it to the museum in his hand, while passing near the place where it was caught, the mother made her appearance and followed the boy for two squares, flying around him, and finally alighted on his breast, such was her anxiety to succor her offspring. Both were brought to the museum, the young one firmly adhering to its mother's teat. This faithful creature lived two days in the museum, and then died of injuries received from her captor. The young one, being but half-grown, was still too young to take care of itself, and died shortly after."

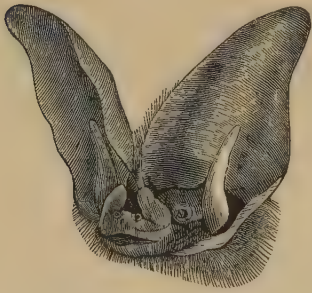


FIG. 91.—*Plecotus macrotis*,
large-eared bat.

The *Plecoti* have the nostrils margined behind by rudimentary nose-leaves, or by grooves on the upper surface of the muzzle; the ears are generally very large, and the forehead is grooved. Two North American bats are referred to the group.

The *Plecotus* (*Corynorhinus*) *macrotis* is related to the long-eared bat of the British islands, the *Plecotus auritus*. It has six incisors in the lower jaw, and the nostrils are in front of grooves on the upper surface of the muzzle, concealed by converging glandular prominences, but there is no vestige of a disk or nose-leaf. The ears are very large. The species is found in the southern and

western part of the United States, and extends on the Pacific coast northwards at least to Vancouver's Island.

The *Antrozous pallidus* is distinguished from all other American bats by the persistence of only four incisors in the lower jaw, and by having the margins of the nostrils continuous in the rim of a small disk, above. The species has as yet only been found on the Pacific coast or southwestern regions of the United States, where it is known to occur as far east as Texas, and to the northwards, in Oregon. Almost nothing is known of its habits.

There are many bats inhabiting the tropical regions of both hemispheres which have a close general resemblance to the common bats of the temperate regions, but which possess characters sufficiently distinctive to merit recognition under a distinct family name: EMBALLONURIDÆ and Brachyura are the names that have been applied to them. These have the hair with verticillate spinules arranged in zones, the tips of the hair-scales being in a straight line at right angles to the longitudinal axis of the hair, and nearly always terminating in acute projections. The ears are normally large, separated from each other, and have tragi of ordinary proportions. The muzzle is obliquely truncated. The nostrils open by simple or valvular apertures, and are not surrounded by nose-leaves; the wings are normally developed; the hind-limbs are quite long; the tail is slender, and perforates the interfemoral membrane on its upper surface, or terminates in it; the upper incisors are in most genera large, separated from the canines and also in front, and their tips are directed slightly forwards and inwards; the molars are well developed, and have distinct W-shaped cusps.



FIG. 92. — Emballonurine type of bat-hair.

Of this type about nine genera are known, which are divided into four groups, Furia, Emballonura, Dicliduri, and Rhinopomata.

The Furia have the interfemoral membrane large, and the tail short and entirely contained in the membrane; the index finger is formed by the metacarpal bone alone; the crown of the head is greatly elevated above the face line, and the thumb and first joint of the middle finger are very short. This group comprises two South American bats, the *Furia horrens* and *Amorphochilus schnablii*.

The Emballonura have also a large interfemoral membrane and short tail, with the index and middle fingers as in the preceding, but the tail perforates the centre of the interfemoral membrane and projects from its upper surface, and the crown is but little elevated. Five genera are known, three of which inhabit the old world and the other two the new; the typical Emballonura range from Madagascar to the Navigators Islands.

The Dicliduri have also the interfemoral membrane and tail as well as index and middle fingers like the preceding, but part of the tail is suspended in a fold derived from the lower surface of the basal part of the interfemoral membrane, the terminal portion perforating the bottom of a pouch formed in the centre of the membrane; the crown of the head is slightly elevated above the face-line, and the forehead is deeply concave; the extremity of the muzzle is produced beyond the lower lip, and the thumb is very short. Of this type two South American species of a single genus, *Diclidurus*, are known.

The Rhinopomata have the interfemoral membrane much shortened, and the tail extended out beyond it; the index finger has two joints; the premaxillaries are united; the incisors are very weak. This type is represented by a single species, *Rhinopoma microphyllum*, which ranges from Egypt through Asia Minor to India and Burmah. It is regarded as being of special interest from the fact that through the presence of two joints in the index finger, the development of the feet, and the form of intermaxillary bones, it comes most closely of all genera of insectivorous bats to the Pteropine, or frugivorous ones. According to Jerdon, this bat frequents old ruins, caves, clefts, rocks, etc. In 1848 many were captured in a house in Madras for three successive nights, this bat not being of common occurrence then in general. They had probably been blown over by the strong westerly winds, that had just set in, from the rocky hills to the westward of Madras.

Another group of Bats, apparently entitled to be considered of family value, and called the *MOLOSSIDÆ*, are closely related to the *Emballonuridæ*, and in fact only distinguished as a sub-family from the forms to which the latter name is here restricted, by Dr. Dobson. These bats have the muzzle broad, obtuse, and equally truncated; the nostrils open by circular apertures, their projecting margins terminating the muzzle in front; the wings are very long and narrow, and adapted for rapid flight; the legs are very short and robust, and the fibula quite stout; the tail is thick, and produced beyond the interfemoral membrane, which is quite short; the premaxillary bones are close together in front or united, the upper incisors are well developed, and the molar teeth have large W-shaped ridges, whose tubercles are large and acute. But three genera of this family are known, *Molossus*, *Nyctinomus*, and *Chiromeles*.

The *Molossi* are confined to America, but the *Nyctinomi*, which are quite closely related, are found in the warmer regions of both hemispheres. One species, *Nyctinomus nasutus*, is found in the southern portion of the United States. As the species in question is the only member of the family found in the United States no special description is necessary, since it may be at once recognized by the family characters; the length of head and body together aggregate two and one-fourth inches, and the tail one and three-fifths.

Dr. R. W. Shufeldt, of the United States army, had the fortune to observe a colony of these bats when stationed near New Orleans, and has communicated to us the following data: "While collecting in Louisiana, during the winter of 1883, I came across this species but once. On the 24th of February, while stationed at Jackson Barracks, three miles from the city of New Orleans, one of my collectors came to me, bearing the information that a large number of bats had collected during the night under the eaves of the barracks. Being a reliable man, and my time being then fully occupied with a large collection that had just come in, I despatched him to bring me as many as he could capture. In the course of half an hour he returned bringing with him an ordinary cigar-box containing thirty-six specimens of *Nyctinomus nasutus*. They were found crowded in a narrow space that existed between the wooden roof of the piazza and the adobe wall of the company quarters, where he had first seen them. The capture, which occurred in the middle of the day, was made by beating them into a sack with sticks, and strange to say nearly the whole number was taken, the effort to escape being made on the part of only a few individuals.

"In the box they were all very much excited, and kept up a continuous creaking chatter, which could be heard at some distance. I noticed, too, that they emitted a powerful musky odor from their bodies, and that the temperature of their limited quarters was raised to about 101° F., while that of the room was only 74° F. This elevation of temperature no doubt was due to the excitement under which they labored, as it rapidly fell during the half hour they were undisturbed in my study.

"I am under the impression that my specimens were all males, from examinations made at the time and since. It may be that the sexes thus congregated apart, but I cannot positively vouch for this. Many bats were killed by me or my collectors during the season that followed, both during the daytime, as they hung in the trees, as well as in the evening when they pursued their usual avocation of insect hunting. These, however, all proved to be of the genus *Atalapha*, and *Nyctinomus* never came to my notice again in that locality. When placed upon the ground this bat behaves very differently from the common species. It moves about with considerable alacrity and ease, reminding one very much of a mouse, and its mouse-like tail only tends to enhance

this resemblance. A superficial examination of my specimens indicates that there are many points of interest in the structure of *Nyctinomus*, and some very pronounced distinguishing characters; but these have not been fully entered upon yet, and I trust to bring them out in my Report on the Zoology of the region."

The *Chiromeles torquatus* is so singular that it also deserves special notice. "The nursing-pouches are peculiar to this species, and are probably absolutely necessary to the preservation of the young, which could scarcely otherwise succeed in maintaining its hold on the naked body of the mother during flight. It is interesting to find these pouches developed in both male and female; for their presence in the former suggests the idea that when two young are born together the male may relieve the female in the charge of one of them." It is remarked by Dr. Salomon Müller that "this species is distinguished from the rest of the family not only by its disgusting exterior and the nakedness of its body, but chiefly by a most offensive and noxious odor which emanates from it. This odor is caused by a soft, greasy substance, secreted in a small sinus situate in a transverse fold of the skin above the thorax. It is so pungent and offensive that Mr. Van Oort, while employed in making a drawing of an individual, was afflicted with headache and nausea so severe that he could only with difficulty complete his task."

There are a couple of South American bats, which in most respects resemble the previous forms recognized as the Emballonuridæ, but they have unusually strong upper incisors, — the two median of the upper, and the only two of the lower jaw seeming to resemble the front teeth of rodents. By Linnæus one of the species was recognized as a distinct generic type called *Noctilio*, and was placed far apart from all the other bats, and referred even to the order of Glires or rodents. By Dobson these bats are placed in the group Noctiliones of the Emballonuridæ, but he has suggested that they might require to be isolated in a distinct family. This suggestion seems eminently proper, and the family NOCTILIONIDÆ was indeed many years ago proposed with such forms as the typical representatives. The Noctilionids have large ears arising separately from the sides of the head, and with well developed tragi; the nose projects over the lower lip, and the apertures of the nostril are oval and close together, and without surrounding folds or a leaf; the wings are moderately developed, and essentially like, but somewhat smaller than those of the Emballonuridæ; the third finger is very long; the legs are moderate. The interfemoral membrane is large and extended in an expanded condition far beyond the short tail which perforates its basal third, and appears on its upper surface; the premaxillary bones are slender, and unite in the centre; the upper inner incisors are moderately long and in the centre of the space between the canines, while the outer upper incisors are very small, and in a plane posterior to the median incisors; the molars have very acute cusps, the W-shaped cusps of the upper ones projecting externally far beyond the lower molars when the jaws are closed. Of the two species one, *Noctilio leporinus*, inhabits Brazil as well as Peru and the West Indian Islands, and the other, *N. albiventer*, has been found only in Bolivia. In Jamaica the habits of the *N. leporinus* were studied by Mr. Gosse. That gentleman obtained living specimens from the interior of a hollow cotton tree. He presented to one a large cockroach, "which he seized and greedily munched up, moving the jaws only vertically. The eating was attended with a loud and very harsh cranching of the teeth, not produced by crushing the horny parts of the insect, for it was equally perceptible when munching a bit of soft flesh. The jaws moved

rapidly, but yet the mastication was a long operation, for it appeared to be performed almost wholly by the canines. As the insect was progressively masticated, portions were allowed to fall in the cheek-pouches (the one being pretty well filled before the other was used), which when full hung down on each side of the lower jaw to the depth of three or four lines, like distended bags, displaying a warted surface. When the whole of one cockroach had been masticated, and deposited in the pouches, it would take another, which was rapidly disposed of in the same receptacles; then, after a few moments' intermission, by a contortion of the jaw, aided by the motion of the muscles of the pouch, a portion was returned to the mouth and again masticated. This was repeated till all was swallowed, and the pouches appeared empty and contracted out of sight. Small portions of the muscle of a bird, which were presented to one, he chewed up and deposited in the pouches; but after being regurgitated and a second time masticated, they were expelled instead of being swallowed. The process of eating seemed an awkward one. It was a rapid succession of choppings with the long canines, through which the tongue was thrust about so nimbly that it appeared a wonder it was not impaled perpetually.

"In order to rest like other bats they crawled upwards and backwards by means of the hind feet, seeking the greatest elevation they could attain which afforded a hold for the claws. They were social, though both were males, usually hanging side by side, or sometimes with the leg of one crossing the leg of the other, or even one upon the other. Sometimes they brought their faces together and licked each other's open mouths in a singular manner; and this appeared grateful to them."

Mr. Fraser also observed this species in Ecuador, skimming the bank of a river, every now and then making a dash downwards and catching "minute shrimps," as they passed up the stream. One caught had "a very offensive fishy smell," — a characteristic probably incident to individual habits, as no mention was made of such a trait by Mr. Gosse.

Next may be considered the family of the American nose-leafed bats, or *PHYLLOSTOMIDÆ*. The scientific name is derived from *phyllos*, a leaf, and *stoma*, mouth. These have hairs like those of the preceding (*Emballonuridæ*); the wings have a goodly expanse, and a third joint is always developed in the middle finger, whilst the first joint of that finger is quite short; the nostrils open on the upper surface of the muzzle, and their apertures are more or less surrounded by cutaneous appendages which form a distinct nose-leaf; the ears are moderately large, and tragi are always present; the tail penetrates the interfemoral membrane and either juts out from its upper surface or is produced beyond it; the premaxillary bones are well developed and connected together; the teeth are quite variable.

These bats are confined to America, and are especially numerous in the southern continent, where they are exemplified under many distinct forms. While some are mainly insectivorous, others appear to live on a mixed diet of insects and fruit, and, according to Dr. Dobson, there appears to be a correlation of development of the tail and regimen. It is remarked by him that probably all those with the tail and interfemoral membrane well developed feed principally on insects, while the greater number of others appear to live chiefly or wholly on fruits. According to the same author, from the large development of the antebrachial membrane it may be inferred that the species of this family are unfitted for walking on a horizontal surface; and this is quite in accordance with the observations of those who have noted their habits. They are

therefore, "in this respect, in direct contrast with the Molossinæ. The insectivorous species capture their prey on the wing, while the frugivorous hang suspended from a branch of the tree on the fruit of which they may be feeding, this position allowing free motion to the arms and thumbs, which the animal uses for holding its food to its mouth." The various forms of this family may be segregated under three sub-families, — the Phyllostomines, the Glossaphagines, and the Stenodermines.

The Phyllostomines are those nose-leaved bats which have a long and narrow muzzle, a tongue of moderate length having an obtuse tip, and whose lower lip is entire and not divided at the centre by a groove; the true molars have W-shaped cusps on their outer side. In this sub-family thirteen genera are recognized. It has one representative in the United States — the *Macrotus waterhousii*.

The *Macrotus Waterhousii* is found in Mexico as well as the West India Islands, and extends upward into California, in the United States, and possibly may occur also in Florida. It may be distinguished from all other species of the Republic at once by the nose-leaf, which is simple in front; the chin has a deep V-shaped groove, which is margined by raised naked prominences or warts. The animal, including the head and body, is a little over two inches and a half long, and the tail is nearly or quite as much as one and a half; its tip is free. Its habits have been observed chiefly in Jamaica. In that Island it is prone to inhabit caves, and when found about houses it is chiefly in cellars and below ground; they are said never to be found under the roofs. When placed on a horizontal surface it was observed not to



FIG. 93. — *Macrotus waterhousii*,
American nose-leaved bat.

run, but to leap into the air at once and readily take to flight. The species appears to be truly carnivorous, although it is by no means exclusively so, and adapts itself readily to fruit. Mr. Osborn noticed in an open verandah a number of spiders on the wall, on examining which he detected "seeds of the fustic berry (*Morus tinctoria*) sticking to the wall in the dry pulp by which they were surrounded." These spiders were caused by the long-eared nose-leaved bat, or *Macrotus*. According to Mr. Osborn, the bats "came in at night, hitched themselves up, when a chewing might be distinctly heard, and then these splashes on the ground. One let the wings and legs of a large grasshopper drop. The berries," it was observed, "were the fustic, breadnut (*Brosimum alicastrum*), and the rose-apple (*Eugenia jambos*)." In the stomach of one of the bats "a yellowish mass, with fragments of harder parts of insects interspersed," was found, and among these were legs of orthopterous insects. A female evinced unnatural savageness of disposition. A young one which had been deprived of its mother was placed in a cage with the animal. The young one tried to cling to this as to its mother, but was seized by her and savagely bit, the victim being held between her teeth; and on examination the stomach of the cruel animal was found to be full of coagulated blood, part of which was in the intestine.

The Glossaphagines have the muzzle long and narrow, — even more so than in the preceding, — and the tongue is much more elongated and attenuated toward the tip; and the lower lip is divided on its upper surface in the centre by a deep groove. Seven genera of this type are recognized by Dr. Dobson, but none of these extend into the United States, although several are found in Mexico, and one of them, *Phyllonycteris sezeicorni*, is an inhabitant of Cuba. The habits of this species were observed by Mr.

Osborn of Jamaica, and inasmuch as they serve to throw light on the functions of the tongue his account may be here transcribed. Some clammy cherries were fed to several individuals in captivity by Mr. Osborn. "The tongue was rapidly protruded and drawn in again, and the juice and softer pulp cleared away with great rapidity. I noticed he was very particular in cleaning out the bit of loose skin of the berry, and licked my fingers of the juice spilled on them, carefully cleaning out any that had collected under the nail. I then got another berry. The bat was hanging from the edge of the box, its ventral surface against the side; and as I held the berry a little off so as to see the action of the tongue, it had, whilst feeding, to bend the neck so as to raise the head a little. This seemed to fatigue it. It therefore raised itself on one wrist, and turned around so that its back was against the box's side; but as it did not change the position of the feet of course the legs crossed, the right foot being now on the left side, and *vice versa*. In this odd position it appeared perfectly at ease, and went on licking at a fresh berry with great relish. As the pulp and juice became exhausted I expected it would drop it, and was prepared with another berry; but to my surprise he brought up the wrists to the muzzle, took the berry between them, gave it two or three energetic bites, and then held the berry off. So I now understood what the unusually long thumbs were for; for they applied themselves dexterously to the berry, held it firmly, and then, as it appeared to me, by a reverse action of the two wrists the berry was turned round, a fresh hold taken by the teeth, and the same licking process renewed till the seed in the centre was cleaned of the pulp, all but the little bit that served for the last tooth-hold. It was then dropped, and the eager little muzzle raised for more. I then took them up and put them among the twigs of *Cordia*. They climbed about it, heads downward, with the greatest ease. The length of the legs and toes, their muscularity, and the absence of any interfemoral membrane, were all obvious advantages where this habit was constant, especially the power it gave them of turning as on a pivot, but without moving the feet."

The *Stenodermines* are such nose-leafed bats as have a short, broad, and obtuse muzzle, and whose true molars are broad and flat, with an outer notched cutting-edge; the tongue is of moderate length. The species are almost entirely frugivorous. Nine genera of these forms are recognized by Dr. Dobson, all of which inhabit tropical America.

The typical genus, *Stenoderma*, has three species, and one of these is common in the islands of Jamaica and Cuba, and is named the *Stenoderma achradophilium* on account of its predilection for the rose-berry, *Achras sapota*. According to Mr. Gosse, it feeds especially on this fruit. Mr. Gosse observed that about a quarter of an hour after sunset, and while the horizon was still glowing with effulgent clouds, these bats were wont to fly round a rose-berry tree; and on picking up fruit that had been just bitten it was found to be nibbled in a ragged manner. Fragments of rose-berry of considerable size, partly eaten by a bat, are frequently found at the distance of half a mile from the nearest roseberry tree. The rose apple (*Eugenia jambos*) is also a favorite fruit.

The genus *Artibeus* is also one of the *Stenodermine* bats, represented by a species in the West Indies, and South American representatives "are found throughout the tropical regions wherever tree-fruit is abundant, of which their food principally if not altogether consists."

According to Dr. Dobson, "as might be supposed from the large size and nakedness of the eyes in the species of this genus, they are rather crepuscular than nocturnal

in their habits, and often choose for their habitations places considerably exposed to daylight. Mr. Osborn has noticed that *A. perspicillatus* particularly haunts the entrance of caves, or caves of small depth; and he found them in great numbers in Aquatta vale, Jamaica, clustering under the fronds of the cocoanut palm. The writer (Dr. Dobson) also found a colony of a closely allied species, *A. planirostris*, roosting under the slightly projecting eaves of a house in Demarara, where they were exposed to the full glare of the setting sun."

Closely allied to the Phyllostomidæ are certain bats which have even been associated in the same family with them, but which, following the example of several authors, may be here considered a family, with the name MORMOPHIDÆ. These have the hair, wings, and digits like the preceding, but possess simple nostrils perforating the front muzzle, and there is no distinct nose-leaf. In most other respects they essentially agree with the Phyllostomidæ, although the position of the nostrils and the absence of the nose-leaf, as well as the development of peculiar leaf-like appendages at the chin, give the species a peculiar physiognomy. But two genera of this type are known — *Mormops* and *Chilonycteris*. One species of *Mormops* — *M. blainvillii* — is an inhabitant of Jamaica and Cuba, and in the latter island its habits were studied by Mr. Osborn, who communicated his observations to Dr. Dobson. Its whole structure manifests "an extreme fragility and thinness," and "the light was visible through the roof of the open mouth." The tail curls "upward so as to carry the interfemoral with it; this was caused by the calcaneum bearing up the interfemoral." The hind limbs, and especially the femora, were long, so that in repose "the knees were above the back, like a grasshopper's. It easily took wing off a flat surface, and its efforts to escape during the night broke some of the phalangeal bones. It refused flies, but it drinks greedily. The tongue was protruded, but the water taken up by it and the foliations of the lips was sucked in with the head raised, by an action very like chewing."

The last family that remains to be considered is one consisting of a couple of genera which are remarkable for their sanguinivorous propensities, and for the modifications co-ordinated with such habits: the family has been named DESMODONTIDÆ. In most respects they are closely related to the Phyllostomids, and have been associated with that family as a simple group by Dr. Dobson, but by Professor Huxley they have been differentiated into a primary group of the order co-ordinate with Frugivora and Insectivora, and which has been named by him Hæmatophilina. The hair is of the emballonurine type; the ears are large and have well-developed tragi; the muzzle is short and conical; the nose-leaf distinct, and the nostrils open on the surface of the horizontal leaf; the wings are moderately developed and broad, with three phalanges in the middle, and one in the index finger; the interfemoral membrane is atrophied, and the tail absent. The teeth are limited to twenty or twenty-four in number, the true molars being absent or rudimentary; the upper incisors are very large and developed in the form of canine teeth, close and convergent together; the premolars are narrowed, and have sharp-edged longitudinal crowns. The œsophagus is very narrow; and, above all, the stomach is remarkably modified and different from that manifested in any other form, it being greatly elongated at the cardiac extremity, and developed as an elongated cæcum.

The fact that certain South American bats feed upon the blood of other animals has been long known, but it is within comparatively recent times that the species with

such perverted tastes have been identified. Indeed, for a long time the truth of the statements current in South America was either denied, or the sanguivorous attributes ascribed to innocent species. Linnæus, for example, gave the name *Vespertilio spectrum* to one that was supposed to be the culprit, and Geoffroy St. Hilaire subsequently proposed for them the generic name *Vampyrus*. And thus we have the horror-suggesting name of the Ghost-Vampyre perpetuated for a species which is now known to be one of the most innocent of the order, and which confines its diet almost solely to fruit. It is a fact, however, that there are sanguivorous species, and the parts are modified for this peculiar diet, exhibiting remarkable deviations in structure



FIG. 94. — *Vampyrus spectrum*, false vampyre.

from all the others. By means of the foremost incisors, which are very much enlarged, convergent, and with points close together and acute, they nip and pierce the skin of the animal to which they affix themselves, and by a peculiar arrangement of the oral and intestinal parts they ingest and assimilate the blood which is obtained by suction with the lips. The first positive observer of the species which is guilty of these vampyric acts was the illustrious Charles Darwin. In his voyage around the world in the "Beagle," at the commencement of his career, while in Chili his attention was drawn to the fact. In his own words, "The vampyre-bat is often the cause of much trouble by biting the horses on their withers. The injury is generally not so much owing to the loss of blood as the inflammation which the pressure of the saddle after-

wards produces. The whole circumstance has lately been doubted in England. I was therefore fortunate in being present when one (*Desmodus d'orbigny*) was actually caught on the horse's back. We were bivouacking late one evening near Couimbo, in Chili, when my servant, noticing that one of the horses was very restive, went to see what was the matter, and, fancying he could detect something, suddenly put his hand upon his withers and secured the vampyre." These observations have subsequently been confirmed by others, and it may be considered established that the two species, which are the only bats known to possess the peculiarities of organization above described, are dependent mainly on blood sucked from other mammals for sustenance. The second species of the family is *Diphylla ecaudata*, an inhabitant of Brazil. The *Desmodus rufus* (*D. d'orbigny* of Darwin) has a much more extended range, occurring not only in Brazil, but extending into Chili, and thence northward into Mexico.

THEODORE GILL.

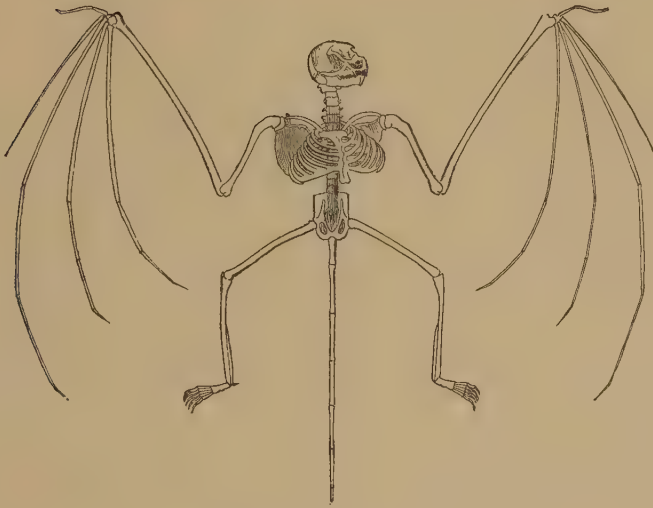


FIG. 95. — Skeleton of bat.

ORDER V.—CETACEA.

The Cetacea, or whales, dolphins, and their kin, are the mammals of the sea, — hot-blooded, air-breathing creatures that have become specialized for a life in the broad domains of ocean, over which they reign supreme, the despotic devourers of lower vertebrate and invertebrate life. Though shark or sword-fish may occasionally destroy the smaller dolphins, no finny cold-blooded monster is a match for the rapacious orca, with his terrible array of teeth, untiring activity, and matchless velocity; the great whalebone whales are secured by their size and strength from the attacks of any creature not belonging to their own order; and in the jaws of the huge sperm-whale, the long arms and deadly suckers of the kraken avail it nought — its struggles are powerless as those of a mouse in the clutches of a cat.

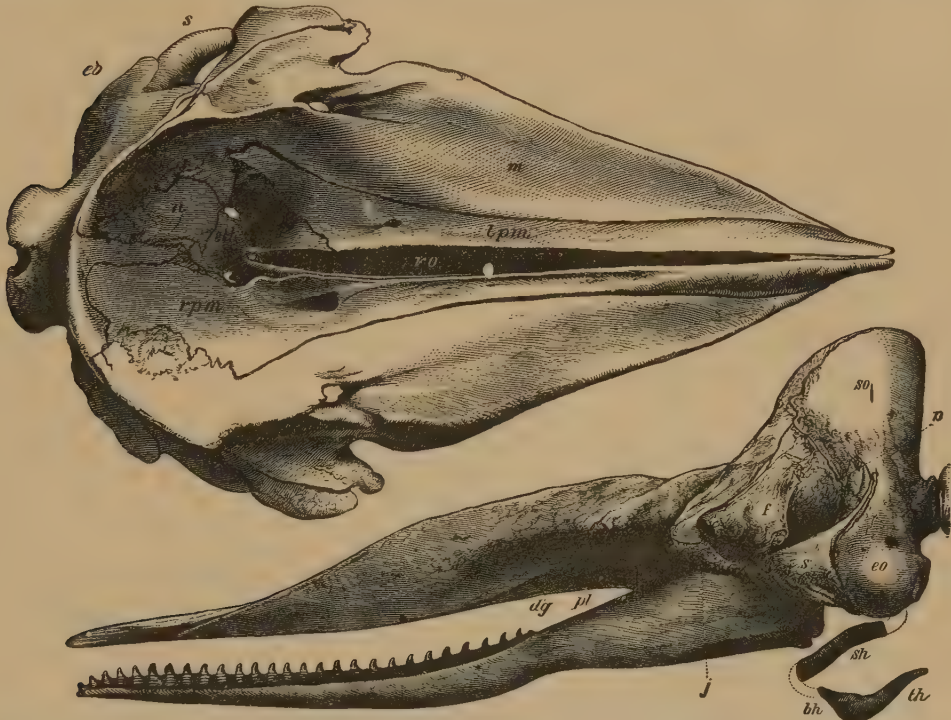
The Cetacea are fish-like in shape, and this coincidence of form, joined with a similarity of habitat, has caused, and still causes them to be popularly regarded as fishes, while the chase for them is known as the “whale-fishery.”

To preserve the physiologically active body, kept by the rapid consumption of oxygen at a temperature slightly higher than that of the mammals of the land, from injury from the cold element in which it resides, it is encased in a thick layer of fat or “blubber,” for the sake of which man fits out vessels provided with hand-harpoons and lances, or, more murderous still, with the destructive bomb-gun, and so cruelly persecutes these, to him, defenceless creatures, that some of them have become scarce. One group of the Cetacea, the whalebone whales, the hugest of all existing animals, yet toothless, and provided with numerous long laminæ of horny substance, fringed with hair, are more persecuted by man than any other, for the “baleen” is of equal or greater value to him than the oil.

The Cetacea have no neck; the outline of the head passes into that of the body, and in many cases the head is the broadest and deepest part of the entire frame, which tapers from it backward. The bones of the neck are short, and usually more or less fused together, so much so that in some cases the entire seven vertebræ form but a single bone. The second vertebra (atlas) is devoid of the odontoid process or peg upon which the head (in other mammals) rotates, and the bodies of all the cervical vertebræ are often mere disks. Stiffness and stability is thus secured in the anterior part of the spinal column, while flexibility and elasticity are conferred upon the remainder by the great thickness of the cartilages interposed between the centra of the vertebræ, which are large in proportion to their processes. Of the two pairs of limbs usually present in the Mammalia, the Cetacea have only the anterior, and these are modified so as to appear externally as broad, flattened paddles, without separation into digits, and without indication of nails. Within this leather-covered paddle are bones more numerous than those usually found in the class, for though the digits do not exceed five, some have more than three phalanges. The wrist-bones (carpals) are not articulated to each other, but are imbedded in a fibrous tissue; and the radius and ulna are short, flattened bones incapable of movement upon each other, and not freely movable upon the short, thick humerus. The shoulder-bone is comparatively large, broad, and stout, and there are no clavicles.

Although the hinder limbs are externally absent, there remain within the body the traces of a former functional pelvis in the form of two rather small elongated bones, which probably represent the ischia, and are connected with the backbone by fibrous

tissue. Thus, in the structure of their limbs, the Cetacea are lowest of all Mammalia, degraded, by life in an element which affords them no hard surface on which to exercise



FIGS. 96 and 97.—Skull of adult sperm whale from above and from the side. *bh*. Basihyoid. *eo*. Ex occipital. *f*. Frontal. *lpm* and *rpm*. Premaxillaries. *m*. Maxillary. *n*. Nasal. *p*. Parietal. *pl*. Palatine. *s*. Squamosal. *sh*. Stylohyoid. *so*. Supra occipital. *th*. Thyrohyoid. *vo*. Vomer.

their limbs, to such a point that their hind limbs have become atrophied, and their fore limbs converted into pectoral fins. The external resemblance to fishes is heightened by the invariable presence of a broad, double-lobed caudal fin, which is, however, flat-

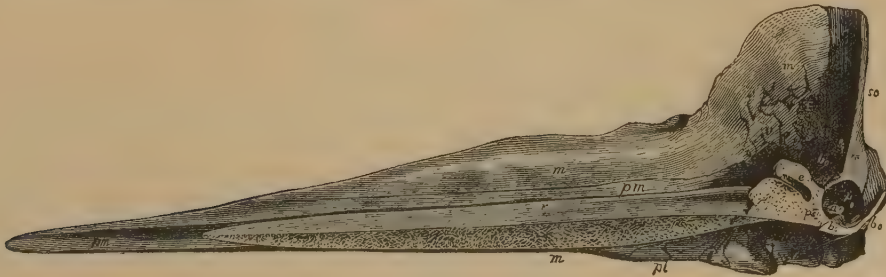


FIG. 98.—Longitudinal section of a skull of a sperm whale, showing the relatively small size of the cavity for the brain. *as*. Alisphenoid. *bs*. Basisphenoid. *bo*. Basioccipital. *e*. Ethmoid. *p*. Cranial cavity. *pm*. Premaxillary. *ps*. Parasphenoid. Other letters as before.

tened horizontally instead of vertically (as is the case in fishes), and by the very general, though not universal, production of a raised, fleshy, compressed dorsal fin from some point between the head and the caudal. But, degraded though the Cetacea are, the convoluted brain, and the perfection of all their internal organs, point to a descent

from the higher rather than from the lower Mammalia, and, though our knowledge of their habits is but meagre, evidence is not wanting that they are endowed with considerable intelligence.

The structure of the nasal cavities in this group is widely different from that found in any other mammals. As the dolphins have no olfactory nerves, and the place usually occupied by the sieve-like plate through which the nerves pass is filled by imperforate bone, the sense of smell must be wanting; but the nostrils in both whales and dolphins, instead of ending at the tip of the snout, are continued upwards through the flesh to the summit of the head, where they open externally by one or two apertures, called spiracles or "blow-holes," and form the means by which these animals can breathe without raising the front of the head out of water.

The eyes are small, and devoid of a third eyelid; the ears are destitute of any trace of an external pinna, though internally they do not greatly differ from those of other mammals, and touch and taste appear to be well-developed. The female possesses two



FIG. 99.—Skull of sperm whale from beneath. *pt.* Pterygoid. Other letters as before.

teats, lodged in depressions on each side of the vulva. Adults are almost entirely destitute of the hairy covering usual among mammals.

Among the peculiarities of the skeleton are the want of a sacrum, correlated with the atrophy of the hind limbs; the absence of the usual articulations between the arches of the lumbar and caudal vertebræ, which thus possess the great mobility necessary for the effective play of the great caudal fin, the powerful vertical strokes of which are the agents by which the heavy bodies of the Cetacea are driven onwards through the water; the small number of ribs which are connected with the breastbone; and the singular modifications undergone by the bones of the skull. In all Cetacea, that part of the upper jaw which lies in front of the bony nostrils is much prolonged, resulting in a great development of the maxillary and inter-maxillary bones, the former of which extend backward and outward over a large, or even over the greater part of the frontals. The frontals are large and broad, extending outward into broad, bony plates that cover the orbit, and backward on the summit of the head till they join the supra-occipital bone, which is greatly developed; so that the parietals are entirely excluded

from the upper surface of the head, and instead of meeting in a sagittal or median suture, as usual in Mammalia, are comparatively small bones, placed low upon the sides of the cranium. The supra-orbital extension of the frontal is met by a stout process from the squamosal part of the temporals; the jugal bones are small and slender; the nasals are short and sometimes reduced to bony processes of the frontals, thus allowing the nasal passages to be nearly vertical; the turbinals are usually rudimentary, and the periotics or "ear bones" are so loosely connected with the skull that they readily fall out in a prepared skeleton. Another peculiarity of the cranium in this order is its want of symmetry. This is least observable in the true whales or Balænoidea, while in most of the rest of the order the entire facial part of the skull is distorted.

The teeth, when present, are not distinguished into incisors, canines, and molars, but are similar, of simple structure, and usually of conical shape. They have no successors. The sockets in which they grow are often incompletely separated from each other, and no tooth in the living forms has more than one root. Salivary glands appear to be absent; and the soft palate is very long and muscular.

The stomach of the Cetacea repeats, in some respects, the character of that of the ruminants, since it is divided into several compartments. This similarity of structure between an entirely carnivorous and an entirely herbivorous group is very remarkable, and, coupled as it is with the existence of a fold or groove, like that occurring in the ruminants, between the first and second compartments, has led some naturalists to suspect that the Cetacea have the power of chewing the cud. Others deny this, and assert that the incompleteness of the groove, as well as its termination in the second compartment instead of in the third, would necessarily cause a difference in the process. This complexity of stomach lends probability to the idea put forward by Professor Flower, that the Cetacea may have descended from ungulate ancestors.

However this may be, the Cetacea have highly complex stomachs, and this complexity is doubtless correlated with some physiological peculiarity. In the beluga or white whale, five compartments exist, reckoning as one a small chamber, not visible on an external view of the stomach, interposed between the second and fourth, both of which are large. The fifth, in which digestion takes place, is long and narrow, tapering from commencement to end, and recalls the abomasum or fourth chamber of the ruminants. The number of chambers in the stomachs of other cetaceans is variously reported, probably because the small hidden chamber above mentioned, as well as the duodenal dilatation, have been omitted by some, while one or both have been counted by others. The grampus or orca has five; *Delphinus*, four or five; the narwhal and *Platanista*, five; the porpoise, three or four; *Hyperoodon*, seven; and *Ziphius*, eight. The sperm whale is said to have three, while the whalebone whales are credited with four.

The intestines are longer in the toothed Cetacea than in the true whales, for, while in the rorqual they are rather more than five times the length of the body, they are, in the beluga and the common dolphin, more than six times; in *Grampus rissoanus*, seven times; in *Globiocephalus* and *Delphinus orca* at least eight times, and in the sperm whale more than sixteen times the length of the body. No cæcum exists in the toothed whales, nor is there any distinction between large and small intestines. Few of the Cetacea have a gall bladder, and in most of the order the hepatic and pancreatic ducts unite before they pass through the intestinal walls.

The whalebone whales have a large ventral air-sack connected with the larynx, and this was once thought to be a structure peculiar to them, but the beluga and the gram-

pus have also a small air-sack, and Messrs. Watson and Young consider the structure to be equivalent to the ventricles of the larynx of other mammals.

The epiglottis and the arytenoid cartilages are more or less prolonged, giving the entire glottis the shape of a funnel, the apex of which is embraced by the soft palate, so that a continuous passage is formed from the internal nostrils to the larynx, dividing the gullet into two passages. Thus a cetacean is able to swallow while breathing. The very short trachea gives off a third bronchus to the right lung.

In order to afford reservoirs of blood for the use of the animals during their long stay below the surface, the arteries and veins form great plexuses or *retia mirabilia* in various parts of the body, especially in the cavity of the thorax, on each side of the spinal column, and between the ribs. The veins are almost entirely without valves, and this, together with the pressure of the sea-water at the depths to which the animals descend in the hope of effecting their escape, accounts for the fatal hemorrhage which follows the puny wound inflicted by a lance in the hand of a man.

The earliest appearance of cetacean remains in the strata of the earth's crust is in the eocene, and they occur in all subsequent formations. Among the most remarkable is the extinct *Zeuglodon*, the type of the sub-order Phocodontia, and apparently in many respects intermediate in character between the Sirenia (manatee and dugong) and the Cetacea, while in others they connect the seals with the latter order.

Another Phocodont is *Squalodon*. In this sub-order the neck vertebræ are separate, the skull is symmetrical, the nasal bones are longer than in the other Cetacea, and there are molar teeth with laterally-compressed crowns, serrated edges, and two fangs, like those of many seals. *Zeuglodon* differs from all other Cetacea in having vertical successors to some of the teeth.

The Cetacea are divisible into three primary groups: the Balænoidea or Whales, the Delphinoidea or Dolphins, and the extinct Phocodontia.

SUB-ORDER I. — DELPHINOIDEA.

In the Dolphins, the bones of the cranium are always more or less unsymmetrical, owing principally to the union of the spiracles and increased development of the left nasal passage. In its course from the openings in the nasal bones to the summit of the head, the nasal passage is dilated into sack-like chambers of dimensions varying in the different species.

Some of the anterior ribs have heads and necks, and are articulated to the bodies of the vertebræ; the sternum, instead of the broad, short form found in the whalebone whales, is elongated and formed of several pieces, and some of the ribs are united to it by the intervention of bony or cartilaginous sternal ribs.

The maxillaries are produced further upward and backward than in the Balænoidea, so much so that they to a great extent cover the frontal bone; while the branches of the mandible are not arched outward, but are united together for a greater or less distance, and often form with the cranium a pronounced narrow beak. Teeth, in variable numbers, are always present. The Delphinoidea may be subdivided into several families, namely, Ziphiidæ, Belugidæ, Orcadæ, Delphinidæ, Platanistidæ, and Physeteridæ.

In the ZIPHIIDÆ, the species of which were not long ago supposed to be extinct, but which prove to be numerous in the Southern Seas, since some fourteen or more distinct

forms are now known, there are never more than one or two pairs of fully-developed teeth in the lower jaw, fitting into pits in the upper one; a dorsal fin is present; the pectoral is short, ovate, and placed low down upon the sides, with five digits beneath its enclosing skin; and the cervical vertebræ are more or less united.

The Australian Two-toothed Whale (*Ziphius australis*) is of a light ash-color, darker on the back, and without the convexity of forehead that distinguishes the New Zealand Two-toothed Whale (*Z. novæ-zelandiæ*), which is known from examples that have been washed; or rather driven ashore, and attains a length of at least twenty-one and a half feet. The head, neck, and anterior parts, as far back as the dorsal, are white, and a narrow white line extends along the edge of the dorsal. The rest is black. There is no gradual blending of the colors into each other.

A female of the latter species, nearly twenty feet long, was driven ashore alive at New Brighton by one or two whales which remained at a safe distance. On examination of the animal after its death, it was found to be scored all over by the marks of wounds, some old and entirely healed, others recent and raw. The wounds consisted of pairs of parallel marks, an inch and a quarter to an inch and a half apart, and also of oval spots enclosing two punctures, the same distance apart. The wounds were, in fact, just such as would be inflicted by the two teeth of another ziphioid whale. The teeth of the females are believed by Dr. Haast to be absorbed with age to such an extent as to disappear below the gums, while even in the young females they are quite small. A male taken at Chatham Island, and probably belonging to this species, agreed with these females in every particular except the size of the teeth, which were two inches long and four inches around. The character of the wounds and the sex of the victim point to but one conclusion, which is, that the males of this species attack and worry the females, inflicting upon them wounds from their two teeth, which are larger in them than in their victims. In the other ziphioid genera the teeth are too far back in the jaw to be used in making the parallel scratches observed in the stranded female, whereas in this species they are in advance of the tip of the upper jaw.

Another species of *Ziphius*, *Z. cavirostris*, occurs along the European coasts, and has been taken off the coasts of Sweden and the Shetland Isles, as well as on other parts of the European coast. It attains a length of more than twenty feet. Ziphioid whales of the genus *Mesoplodon* were until very recently known only from examples of *M. bidens* that had drifted ashore at various points of the European coast; but it is now ascertained that in the southern hemisphere they exist in considerable numbers, and one species at least is gregarious, having in two instances been met with in large schools. Twenty-five individuals of this species, which is called in New Zealand the Cow-fish (*M. grayi*), were on one occasion stranded on the Chatham Islands. Seven good species of this genus are now known, but all, except the European *M. bidens*, appear to be confined to the region from the Cape of Good Hope to the vicinity of New Zealand. The species differ from each in the position, form, and size of the single pair of teeth, in the presence of a groove or a ridge at the base of the rostrum, and other characters. They attain a length of from fourteen to twenty feet.

In the genus *Hyperoodon*, or Bottle-nose Whale, the beak of the skull has a high crest on each side, formed by the elevation of the maxillary bones in front of the blower. The cervical vertebræ are joined into one mass. The only species inhabits the North Atlantic and its adjacent seas and bays, and is now pursued to some extent for its oil, which is said to be equal to that of the sperm whale. In the young the front part of the head forms a beak, but this is obscured in the adults by the develop-

ment of immense bony crests, which finally give the head a form not unlike a trunk or portmanteau. The young and adult have, until very recently, been considered as distinct species.

The family BELUGIDÆ contains but two well-characterized species, the beluga, or white whale, and the narwhal, both of which have short, rounded heads, few teeth, no dorsal fin, a small ovate pectoral, and five cervical vertebrae. The Beluga, or White Whale (*Delphinapterus leucas*) is, when adult, of a uniform yellowish white, or cream color. The young are leaden or bluish black, but soon become mottled, and finally lose all the darker tint. The forehead is boldly rounded, but between the head and the back there is a depression which gives the appearance of a neck. The short, fleshy pectoral is placed further behind the eyes than the latter are from the end of the jaws. There is no dorsal; the spiracle is slightly behind the eye, and the body tapers gracefully above and below to the caudal. An example sixteen and a half feet long measured three feet ten inches across the flukes, and the pectorals were one foot eleven inches in length. The teeth vary from six to eleven on each side of each jaw.

The beluga is a rapid swimmer, and lives upon large fishes, which it not only chases along the shores, but follows up the rivers, sometimes to great distances. Dr. Dall states that in 1863 one was taken by the Russians up the River Yukon at about seven hundred miles from the sea. In pursuit of bottom-loving fishes, such as the halibut, it will often dart into shallows in which there is barely enough water to float its body, yet it betrays no alarm. It is often met with in schools, forming lines two or three abreast, or swimming in single file, spouting at irregular intervals, and showing but little of the body above water. Frequently it will gambol round a vessel, but a noise upon the water or a discharge of firearms frightens it away instantly.

The white whale, of which there may be more than one species, has a wide distribution, as it occurs in both oceans, along the northwest coast of Europe as well as that of America, and on the shores of both Old and New England. A beluga was taken in a singular manner a few years ago in some salmon nets, in the north of Scotland. Coming too close in shore after the salmon, it was caught by the tail between the stakes of the nets, and broke its back in its efforts to escape. On examination it was found that the creature had broken its neck before, but the bones had ankylosed in such a way that the head was fixed on in an unsymmetrical position, and barely room was left near the occipital foramen for the issue of the spinal cord.

A small female, one of three that were taken off the coast of Labrador in 1878, was for a short time an inmate of the aquarium at Manchester, England, but died from the effects of the trip. Dissection showed that the tongue in this species, instead of being free at the tip and along the margins, as in most dolphins, is almost as closely attached as is the same organ in the whalebone whales, as only the tip is capable of motion. There is no trace of tonsils or uvula, and the liver differs from that of any other toothed cetacean in the lack of any division into right and left lobes. True vocal chords are entirely absent, but the sharp inferior borders of the arytenoid cartilages present a similarity to them.

In the singular cetacean, the Narwhal (*Monodon monoceros*), the skull resembles that of the beluga, but instead of the numerous teeth possessed by that and other dolphins, there is but one functional tooth, which forms an immense tusk, projecting from eight to ten feet beyond the tip of the jaw. This tusk is rooted in a socket formed by the maxillary and intermaxillary bones of one side, while on the other, lodged in a

similar alveolus, is a rudimentary tooth, nine or ten inches long, that does not usually project beyond the enclosing bone. This tusk, large in itself, is enormous compared with the animal, whose entire body without the tusk does not exceed thirteen or fourteen feet in length, and eight or nine in greatest girth. To bear the weight, and afford a secure support for this large tooth, the facial part of the skull is broader than in most dolphins, and the alveolus extends back beyond the maxillary notch. The males alone are possessed of this mighty weapon, while the females have two rudimentary teeth in a similar position. Scoresby once took a female which had a tooth four feet three inches in length. In the living animal the upper part of the tusk is covered by a greasy



FIG. 100. — *Monodon monoceros*, narwhal.

crust, but the tip is kept white by use. The entire tooth, though straight, is spirally twisted throughout its whole length, the spiral being marked externally by rounded ridges and hollows that run along the tusk. The head of the narwhal is about one-seventh of the length of the body, the mouth is small, the eyes are on a line with the angle of the mouth; the ears are about six inches farther back, and the pectorals average one-twelfth of the total length of body and head. The central part of the body is almost cylindrical, while the posterior part is conical, with a ridge above and below.

Sucking animals are of a uniform bluish gray or slate tint, and very old individuals are almost white, but most adults have dark gray or blackish spots, of roundish or

oblong shape, scattered about upon the white ground-tint. These spots are about two inches across on the back, where they are darkest and most crowded, become smaller, fewer, and fainter upon the sides, and are almost obsolete upon the belly.

The narwhal feeds upon fish and mollusks, and, notwithstanding its habit of remaining motionless upon the surface for several minutes together, is an active animal. It yields an excellent quality of oil. The Greenlanders and Eskimos put every part of this creature to use; the flesh affords them food, the oil gives them light, the intestines are made into garments and twisted into lines, while the tusks are fashioned into spears and other weapons.

The narwhal is found in the Arctic seas of both continents, but is so rare in the parts near Behring's Straits that the natives have a superstitious dread of its visits.

THE ORCADÆ have blunt, rounded heads; teeth of varying size and number; a dorsal fin; elongated pectorals; and cervical vertebræ more or less united. The principal genera are *Orca*, with a heavy skull, thick lower jaw, and numerous powerful teeth; *Globiocephalus*, with a particularly swollen head; comparatively weak teeth in the front part of the jaws, very long pectorals, and a breastbone of three pieces; and *Grampus*, which has a low dorsal, placed further back than in the other genera, teeth that fall out early in the upper jaw, and are confined to the short symphysis of the lower, and a sternum formed of a single bone. Eight species of *Orca*, eleven or twelve of *Globiocephalus*, and four or five of *Grampus* have been described.

The comparatively diminutive Cetacea belonging to the genus *Orca*, and commonly known as "killers," are probably the only creatures that habitually attack and destroy the great whalebone whales, and even these appear, except when pressed by hunger, to prefer the young of those monsters. The jaws are extremely massive, the entire cranium strongly built, and the teeth large, stout, conical, and few in number compared with those of most other dolphins, resembling in this respect those of the sperm whale.

There are several species, the best known of which are *Orca gladiator* of the North Atlantic, and *O. rectipinna* and *O. ater* of the North Pacific.

The last-named is jet-black above and lighter below, with a clear-white oblong spot just behind the eyes, and a crescent-shaped maroon band on the back, behind the dorsal, which it more than half encircles. The dorsal fin is well developed, and concave on its posterior border.

Rather larger is *O. rectipinna*, the Straight-finned Killer, the dorsal fin of which is almost straight, and six feet or more in height. At its tip this fin is so slender that it often turns over, and the appendage seems altogether too large for the body of an animal, the full-grown males of which measure some twenty feet, and the females about fifteen feet in length, giving to its otherwise graceful motions an appearance of unwieldiness. No parasites reside upon the smooth and glossy skin of these swift corsairs of the ocean,—insatiate devourers that enter the bays and lagoons in chase of seals, dolphins, and whales; who swim up swift rivers in search of salmon and other large fishes, and who destroy more than they devour, killing for sheer love of slaughter. Three or four of these creatures, according to Captain Scammon, will attack the largest whalebone whales, which seem paralyzed by the onslaught, and frequently lie helpless, making no effort to escape, like the hare that suffers itself to be caught by a weasel. The orcas cluster round the head of their victim, seize it by its huge lips, drag it below the water, and eat out its tongue if the mouth is open when it finally succumbs.

On the northwest coast of North America these orcas have been known to seize upon a whale that has been captured by whalers, and to finally bear it away, in spite of blows from boat-spades and thrusts from lances. Especially they haunt the seal islands along the western coast of North America, and gorge themselves with young seals in the breeding-season of those creatures. The largest male sea-lions retreat to the shore when orcas show their fins around, and it is said that the walrus is afraid of them, though Scammon believes that the fear, on the part of animals so well-armed with tusks, must be principally on account of their young. The walrus cub mounts on its mother's back for protection, but the cunning orca dives under the ice, comes up with a sudden shock that shakes its victim into the water, and seizes and swallows it before the eyes of its mother. The network of bays and sounds that stretches along the coast of British Columbia and Alaska is the favorite resort of orcas throughout the year, and they assemble near the mouths of rivers to devour the seals and dolphins that have gathered to feed on the ascending salmonoids. Dolphins overtaken by them are literally swallowed alive, and the orcas may be seen to lift up their heads with a seal in their jaws, shaking and crushing it ere they engulph it in their maw. Further north the beluga is their favorite food. These orcas do not gather into large schools, but are usually in squads of a dozen, or less, though occasionally more may be found together.

The whalers seldom take them, as they yield comparatively little oil; but the Indians of Washington Territory capture them for the sake of their flesh, which they esteem more than that of whalebone whales. The teeth are twelve or thirteen in number on each side of each jaw.

The Orca of the Atlantic, *O. gladiator*, is the equal of the Pacific species in ferocity and destructiveness. Eschricht narrates that it has been seen to swallow four porpoises, and thirteen porpoises and fourteen seals have been found in the stomach of one individual only sixteen feet long.

The best-known species of the genus *Globiocephalus*, which has, as its name implies, a short and rounded head, is *G. melas*, the Caing Whale of Scoresby, tolerably abundant upon the northern coasts of both sides of the Atlantic. The pectoral is large, equal to about one-fourth of the total length of the animal. All the species of this genus associate in large herds.

Another Atlantic species is the Short-finned Globiocephalus (*G. brachypterus*), the Blackfish of the Middle and Southern United States. It is entirely black, with a low, long dorsal situated more anteriorly than that of *G. melas*; a pectoral about one-sixth of the total length, and five or six small teeth on each side of each jaw.

Globiocephalus scammoni, the Blackfish of the Pacific coast, assembles in large schools, and is usually found in the same localities with sperm whales, but nearer the coast, entering bays and lagoons to feed on small fish. It also devours large quantities of squid. The back is nearly straight, curving down abruptly to the tail, and the forehead forms a full quadrant. From end of jaw to tip of tail it measures fifteen to sixteen feet; the flukes are about three and a half feet across, and the pectoral about two-ninths the total length.

The oil is inferior to that of the sperm, and the yield is small, but the flesh, after exposure to the air and proper cooking, is sufficiently savory to tempt whalers to eat it for a change of food. It is most abundant from Guatemala to Peru.

The species of the genus *Grampus* have been popularly confounded with those of the genus *Orca*, which they resemble in their large size, as well as in their general

form, but from which they differ greatly in the small number and diminished size of their teeth. The pectorals are small, and the dorsal low and placed far back.

The best-known species are Risso's Grampus (*G. rissoanus*) of the Mediterranean; Cuvier's Grampus (*G. griseus*) of the North Sea and both coasts of the North Atlantic, and the Cape Grampus (*G. richardsonii*) of South Africa. Scammon mentions several species of *Grampus* as found in the Pacific, and names them the White-headed Grampus, the Bottlenose Grampus, the Panama Grampus, and the San Diego Bay Grampus. The second of these he states to be probably the largest of dolphins, as it attains a length of twenty-five feet. It occurs in schools of ten to thirty, the individuals of which act like small cachalots. It is not certainly known to be a *Grampus*.

The White-headed Grampus (*G. stearnsii*) is about ten feet in length; the muzzle is short, and the dorsal is like that of *Orca ater*, which it resembles in its movements. The head and anterior parts are white, frequently more or less mottled with gray in the region of the dorsal; but the greater portion of the body is nearly black. It is usually found in large schools, though occasionally only two or three wander in company in search of fish and Crustacea. It is extremely wild and shy.

The largest family of toothed Cetacea is that of the DELPHINIDÆ, the members of which have the facial part of the head produced to a greater or less extent into a beak, and are provided with numerous conical teeth in both jaws. In this family the costal cartilages are firmly ossified, and the posterior ribs are without heads, and are articulated only to the transverse processes of the vertebræ by means of the tubercle. Between sixty and seventy species have been described, but it cannot be said that all are well-known or well-characterized. *Neomeris* and *Leucorhamphus* have no dorsal fin. The genera *Neomeris*, *Phocæna* (porpoises), *Orcella*, and *Pseudorca* approach the Orcadæ in the rounded form of the head; but in the other genera the length of the beak increases, until in *Clymenia*, *Delphinus*, and *Steno* it attains one and a half times or even twice the length of the brain-case.

One of the smallest of Cetacea, certainly the smallest of our Pacific coast species, is the Bay Porpoise (*Phocæna vomerina*), which never exceeds six feet in length, and is more usually four or five. The male is black, a little lighter below, but the female has the lower parts milky-white. The pectoral is very small and low down, much behind and below the eyes; the body is very stout in proportion to its length; the head is short but pointed, and the teeth number twenty-one to twenty-six on each side. The favorite resort of this species is the discolored waters between the rivers and the ocean, and it rarely ascends rivers or ventures far to sea. It frequents roadsteads and harbors, and will come close to vessels, but does not exhibit the playfulness of the larger dolphins, and it is seldom that more than six or eight are found together. The Indians of Nootka Sound shoot them as they lie motionless, basking upon the surface.

The genus *Phocæna* includes several other species, all of them of small size. The best known of them is the common Porpoise of the Atlantic (*P. communis*), a familiar object to all who have lived much by the sea-shore. Another Atlantic species is the Banded Porpoise (*P. lineata*), in which a band of rosy brown runs along the side of the body between the black of the upper and the white of the lower surface.

The *Orcella*, or Dolphin of the Irrawaddy (*Orcella fluminalis*), is of a uniform dirty white color, and measures about seven and a half feet in length. It is one of the few species of Cetacea that live in fresh water, as its habitat is the Irrawaddy River, which it ascends to a distance of from three hundred to nine hundred miles

from its mouth. Its nearest relative, the Short-nosed Orcella (*O. brevirostris*) is found along the western coast of the Bay of Bengal, where it frequents the mouths of tidal streams, and is known to ascend the outlets of the Ganges to a distance of seventy to eighty miles from the sea. This species is larger than the Irrawaddy dolphin, attaining a length of fifteen to twenty feet.

The Pacific Ocean possesses two species of the genus *Leucorhamphus*, one of which occurs upon the west coast of South America, the other on that of North America. The former (*L. peronii*), is black above and white below, the dividing line between the two colors passing above the pectorals. It has forty-four teeth on each side of each jaw. *L. borealis*, the Right Whale Porpoise of Scammon, has been seen from San Diego Bay to Behring's Sea. It does not congregate in large numbers, and seldom enters shallow bays or lagoons. The head is less beak-like than in the genus *Delphinus*. The Spectacled Dolphin (*Lagenorhynchus perspicillatus*) is black above, with a black bar above the eye, lead color upon the sides, and white below. Other Atlantic species are *L. gubernator* and *L. leucopterus*; the South Pacific furnishes *L. albirostratus* from South America, and *L. clanculus* from New Zealand; and the North Pacific is roamed over by the species called by Scammon the Common Dolphin of the Pacific (*L. obliquidens*). The last has more than thirty teeth on each side of each jaw, a somewhat sharp snout, and a long dorsal. In color it is greenish black above, with broad longitudinal stripes of whitish gray alternating with dull black on the sides, and pearly or snowy white on the under parts. Scammon states that it congregates in larger numbers, up to many hundreds, has a wider range, and manifests more activity than any other dolphin of the North Pacific. These dolphins frequently play about the bows of a ship under sail, circling around her, and darting across her cutwater, the whole school tumbling and showing their fins in frolic. This species is often found in bays and lagoons where but little fresh water runs in, and lives principally on small fish, which it catches without apparent effort.

Another Pacific species, the Cow-fish of Capt. Scammon (*Tursiops gillii*), is in its habits very much the reverse of the preceding, as it frequents lagoons in quest of fish, and may often be seen lazily moving along below the shade of the mangroves that fringe the shores of Lower California. It is quite solitary in its habits, usually roving singly or in pairs, though sometimes four or five are seen together; and it is often found in company with the blackfish (*Globiocephalus scammoni*), with porpoises, or even with the humpback whale. It is of a dull-black color, lighter below, has a low falcate dorsal fin, and possesses about twenty-four teeth on each side of each jaw.

Delphinus delphis is the Dolphin of the Mediterranean, where it is exceedingly abundant; but its range is not confined to that great sea, as it is found along the west coast of France, visits England in pursuit of the mackerel and pilchard, and is sometimes found even in Norway and Denmark. It is usually about five feet long, but attains a length of seven feet, and is armed with numerous teeth,—nearly fifty on each side of each jaw. The number of teeth is not constant, nor is it always equal on the two sides of the mouth. This species has fifteen pairs of ribs. The palate in this genus has, along each side of the posterior portion, a deep groove, which is absent in *Clymenia* and *Lagenorhynchus*.

Three or four species of the genus *Delphinus* are credited to the Pacific Ocean, but the only one of which anything certain is known is Baird's Dolphin (*D. bairdii*), which has a long and slender beak-like snout, a forehead but slightly marked, and a slender body, that is, for the most part, of a black or greenish-black color above, and

gray upon the sides, while below there is a large lanceolate white patch. There is a white streak above the mouth, and a narrow white strip continued backwards from the angle of the mouth to behind the pectoral. The teeth, about fifty-three on each side above and forty-seven below, are slender and slightly recurved, and the dorsal is erect and conspicuous.



FIG. 101.—*Delphinus delphis*, European dolphin.

The next family, PLATANISTIDÆ, contains only four species, which are distinguished from other Cetacea by the absence of any union or ankylosis among the vertebræ of the neck, and from the true dolphins in the cartilaginous condition of the anterior portions of the ribs. The jaws are very narrow, and the symphysis or line of union of the halves of the lower jaw is very long. The teeth are numerous in both jaws, and have compressed fangs; and the eyes are small — in *Platanista* rudimentary.

Although many species of dolphins ascend the large rivers of America and Asia, none are so completely fluviatile as *Platanista gangetica*, the Dolphin of the Ganges; *P. indi*, the Dolphin of the Indus; and *Inia geoffroyi*, the Inia or Dolphin of the Amazons.

The Inia, which occurs in the tributaries of the Amazons as far inland as Bolivia, and the name of which is that given to it by a tribe of Bolivian Indians, has a long, narrow, cylindrical beak, furnished with scattered, stout, and crisp hairs; broad and elongated obtuse pectorals, and a ridge along the back in place of the dorsal. The teeth vary from twenty-five to thirty-four on each side of each jaw, and all the poste-

rior ones have a large lobe on their inner side. The adult animal is seven or eight feet long.

The Susu (*Platanista gangetica*) inhabits the Brahmapootra as well as the Ganges, and is common as high up as the foot-hills of the mountains. The teeth are numerous, — twenty-eight and twenty-nine on each side of each jaw; the eyes are quite rudimentary, and the posterior teeth are without the tubercle found in the Inia. It feeds upon fish and shrimps. In color it is leaden-gray, slightly lighter below, and it attains a length of six or seven feet.

The Indus species is rather larger, and the color is paler. In both the dorsal is absent.

The remaining family of the toothed whales, PHYSETERIDÆ, contains only two or three known species, characterized by united cervical vertebræ; teeth in the lower

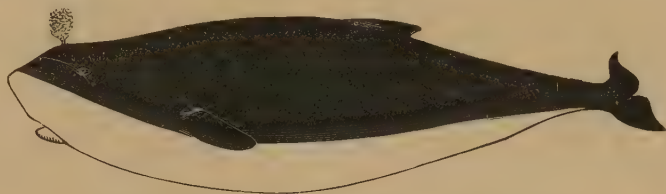


FIG. 102.—*Kogia floweri*, Flower's pigmy sperm whale.

jaw only; ribs united to the breastbone by cartilage; and a strongly asymmetrical skull. The sperm whale is the best-known example of this family, and will be noticed at greater length. The only other established species are those belonging to the genera *Kogia* and *Callignathus*. These, like the ziphioid dolphins, inhabit the Indian Ocean and Australian Seas, and are small compared with the huge sperm whale, yet reach a length of twenty feet, and have a sort of spermaceti in the head.



FIGS. 103 to 105.—Dorsal, lateral, and ventral views of the skull of *Callignathus simus*.

The Sperm Whale, or Cachalot (*Physeter macrocephalus*), is not only the largest and best known of the Physeteridæ, but the largest existing cetacean outside of the division of whalebone whales. An adult male sometimes attains a length of eighty or even eighty-four feet, and examples seventy feet in length are not uncommon. Very nearly one-third of this great length is occupied by the head, which, as in the bowhead or Greenland whale, is also the bulkiest part of the whole frame. In shape it is the greatest contrast possible to that of the last-mentioned animal. The lower jaw is entirely without the huge development of lip, framing in the baleen, that

forms the greater half of the depth in the bowhead, and each ramus or half of the comparatively shallow bone bends inward rapidly, and is united with its fellow in a long and narrow symphysis. What the lower part of the head lacks in size is made

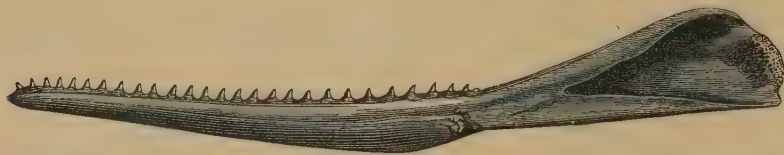


FIG. 106.—Lower jaw of sperm whale.

up by the upper, which forms a huge, almost straight-sided mass, cut off square at the anterior extremity. The blow-hole, instead of being situated above the eyes, as in the whalebone whales, opens at the truncated end of the head. A furrow runs along the upper jaw in the place which is occupied by the whalebone in the true whales, and into this furrow fit the tips of the twenty-two to twenty-four strong, sharp, conical teeth, that are arranged along each side of the long and narrow Y-shaped lower jaw. There are no teeth in the upper jaw. The shape of the skull is strangely unlike that of the head, and is formed on nearly the same plan as that of the whalebone whales, except that the nasals, maxillaries, and contiguous bones are very strongly twisted from the symmetry usual in mammals, and the maxillaries and frontals are curved upwards in such a shape as to form a sort of basin, to which the sailors have given the names of "coach" or "sleigh," as well as the more poetical one of "Neptune's chair." The whole of the vast overhanging mass of the front part of the head is composed entirely of fleshy and fatty matter. Immediately upon the skull lies a mass of cartilaginous, tough, elastic fat, called by the whalemens "junk." Above the junk, on the right side of the head, is a large sac or cavity, called the "case," which contains oil in a fluid state, together with the granulated substance called spermaceti. As much as fifteen barrels of oil have been obtained from the case.

The gape of the cachalot is very wide, as the mouth extends backwards for five-sixths of the length of the head, and the lower jaw is capable of being let down to nearly, or quite, a right angle with the upper. The tongue has but slight freedom of motion. The throat is much larger than that of a whalebone whale, — indeed it is said to be sufficiently capacious to admit the body of a man. The eye is placed a little above and behind the angle of the mouth; and a little further to the rear is the tiny opening of the ear, about a quarter of an inch across.

At the junction of the head with the body is a swell known as the "bunch of the neck;" midway between this and the caudal is a larger bunch, called the "hump," and behind this a series of smaller prominences, known as the "ridge." There is no dorsal. The pectoral, which is situated behind and a little below the eye, is not large, as it seldom exceeds six feet in length by three in width, and the width of the caudal is usually about one-sixth of the total length of the animal.

The spiracle is shaped like the letter S, and in an adult measures ten to twelve inches in length.

In color the dorsal portion of the body is black or blackish-brown, becoming lighter on the sides and below, and silvery-gray upon the breast. Some individuals are piebald. The oldest males are called "gray-headed," because they are grayish upon the nose.

Scammon states that no other cetacean respires with the regularity of an adult male cachalot. As it rises from the depths the hump is first seen, followed by the head, from which issues diagonally a column of vapor, that can be seen from the mast-head to a distance of from three to five miles. The largest bulls, when moving along leisurely, at a pace of two or three miles an hour, make from sixty to seventy-five respirations, occupying in all about twelve minutes. The expiration consumes about three seconds, the inspiration, when moving, only a second; then the head dips below, and in about eight seconds more reappears to blow. Occasionally it makes little or no headway while blowing. When the "spoutings are out," it pitches down head-first, turns its flukes high in the air, and descends to a great depth, staying below from fifty minutes to an hour and a quarter. The smaller and younger males are less regular, spouting some thirty or forty times, and staying below twenty or thirty minutes. In these respects the females behave like the young males.

Very different are the motions of the cachalot when alarmed or sporting. In the first case it will sink instantly, even when in nearly a horizontal position; or if only startled, it will assume a perpendicular posture, with half of the body out of water, to look and listen; or again, when lying upon the surface, will sweep round with its flukes to ascertain if any object is in reach. When at play it is given to "lob-tailing," that is, to raising its flukes high, and striking them down upon the water with great force. It often goes down a few fathoms, and then shoots out bodily and falls on its side with a heavy splash.

The cachalot is seldom infested with parasitic Crustacea, but the whalers say that some of its oddest antics are really attempts to rid itself of the "suck-fish," or remora.

This huge cetacean lives in every ocean not icy, and full-grown individuals have been taken as far as 56° S. Lat., and 56° 12' N. Lat. Yet it abounds far more in the broad, connected waters of the Southern Ocean than in the comparatively shut off basins of the North Atlantic and North Pacific.

The schools, which may contain from fifteen up to hundreds of individuals, usually consist of both males and females, two or three large bulls leading the van. Yet the oldest and largest males roam alone for the greater part of the year, or occasionally form herds by themselves. The females exhibit much affection for their young, assisting it to escape by partly supporting it upon the flipper. They also show great sympathy for each other, and stay by their wounded companions, thus giving the whalers the opportunity to capture several. The young bulls go in herds, but when one is wounded the others swim off.

Occasionally a male cachalot, when harpooned, will lie as if paralyzed, giving the man a chance to finish him with the lance; but more frequently he makes a desperate struggle, and often escapes. Ships have, on various occasions, been sunk by infuriated male cachalots. The "Essex," in 1820, was struck twice, and went down in ten minutes after the second attack. In 1851 the "Ann Alexander" was similarly sunk off Peru. The boats are frequently attacked, and sometimes boat after boat has been demolished by a wise old whale, who, instead of wasting his strength and blood by dragging several hundred fathoms of line beneath a weight of water, has remained upon the surface and fought his pursuers. Captain Scammon states his conviction "that many vessels which have sailed from port and never been heard of after have suffered wreck through cachalots."

Although the exact manner of feeding practiced by the cachalot when in the

depths is not known, yet from its habits upon the surface, from the rapidity with which it can open and close its huge mouth, throwing its lower jaw to a right angle with the upper, and swaying it from side to side at a wide angle, it is believed to swim with its lower jaw hanging down till it comes in contact with the prey. Its food is known to consist of cephalopods, or squids, cuttle-fishes, and octopi, large and small. The beaks of these creatures are often found in the intestinal canal, and it is from remains found within the sperm whale that the existence of giant cuttle-fishes—the kraken of the Norsemen—was first proved. Upon the surface of the water the cachalot

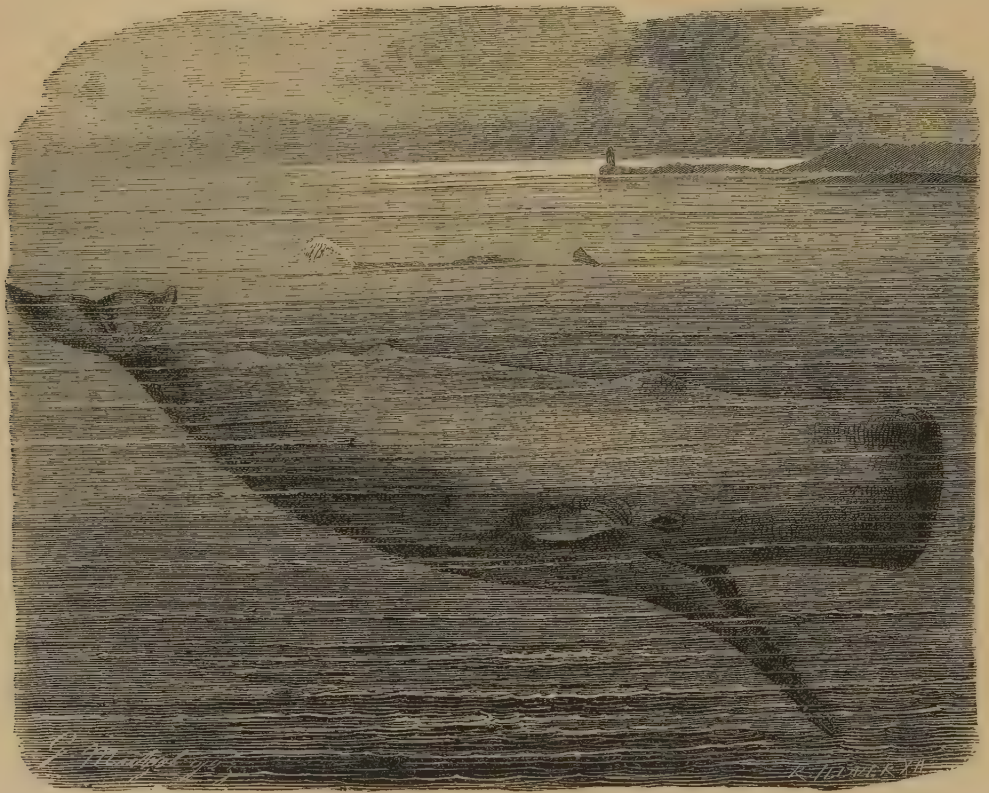


FIG. 107. — *Physeter macrocephalus*, cachalot, sperm whale.

is compelled to turn over in order to grasp a large object, but Scammon believes this is not necessary when below. The female cachalot is very much smaller than the male, not above one-third or one-fourth of his bulk, and is of a more slender form. She is supposed to go with young about ten months, and occasionally bears twins.

It is a singular fact that the epidermis of this whale becomes thinner with age. In the young it is half an inch thick, while in old individuals the furrowed skin is only half that thickness.

The substance known as ambergris, used in Europe and America in the preparation of scented pastilles, candles, balls, gloves, hair-powder, pomades, and other things in which a strong scent is desired, is nothing more than the detained anal concretion of a diseased whale, and is, therefore, composed of the refuse matter of the cephalopods

that form its food. It is usually found in lumps, floating on the sea, and many curious theories were formerly propounded as to its origin.

The classification of the toothed whales is not settled. Professor Flower places the two-toothed Ziphiidæ with the Physeteridæ; and remarks that the groups formed by *Orca*, *Grampus*, beluga, and *Monodon* are much less distinct than the Platanistidæ and Physeteridæ. The Orcadæ and Belugidæ may be, therefore, considered as sub-families of the Delphinidæ.

SUB-ORDER II. — BALÆNOIDEA.

In this sub-order the nasal chambers communicate with the atmosphere by two openings, which are called blow-holes, or spiracles, and are placed upon the highest part of the head. The passages leading downwards from these apertures to those in the nasal bones below are devoid of the nasal sacs which in the dolphins are found between the skin and the skull, but can be opened and closed at the will of the animal.

None of the ribs have a perfect articulation with the bodies of the vertebræ, but are joined to them by ligament, or not at all, so that their chief connection is with the transverse processes. The first rib is the only one which is attached to the breastbone, and thus all the others are false or "floating" ribs.

The skull is very large, compared with the body, and does not present so conspicuous a lack of symmetry as that of the dolphins. The upper jaw is very long and narrow, but the rami of the lower jaw arch broadly outwards, enclosing a space of considerable width on each side of the narrowed cranium, which forms more or less of an arch.

The usual number of young is one at a birth, and the period of gestation appears to be about a year.

The whalebone whales are sharply marked off from the rest of the order by the absolutely edentate condition of their jaws. Yet teeth are present at an early stage of development, though they disappear before the end of fetal life, leaving their place to be supplied by the singular array of parallel plates of "baleen" or "whalebone," about the nature of which there has been much controversy, though there can be none about its use, either to the whale or to its persecutor, man, who for the sake of this useful apparatus destroys its possessor. Probably the nearest approach to a similar structure to be found among Mammalia is, as suggested by Professor Turner, that exhibited by the transverse vascular folds of mucous membrane, covered by epithelium, that cross the palate of the ruminants. If we suppose the epithelial membrane to become horny, as is the case with so many epithelial coverings, to bind together the papillæ of each fold, and to lengthen downwards, we should have horny plates that in position and structure would be baleen. The whalebone whales have olfactory nerves, and a small olfactory organ. The Balænoidea fall into two families, the Balænopteridæ and the Balænidæ.

The BALÆNOPTERIDÆ, or rorquals, all have a head of moderate size; an elongate, fusiform body; short and broad baleen; four digits only; a radius and ulna exceeding the humerus in length; and cervical vertebræ which are not all united together. In most cases a dorsal is present, and the throat and anterior part of the belly is usually thrown into longitudinal plaits. To this tribe belong, beside the true fin-backs, the

scrag whale (*Agelaphus gibbosus*) of the North Atlantic, a species with whitish baleen, and without a dorsal, attaining, perhaps, some fifty feet in length, and the humpback and California gray whales. Dr. Gray enumerates seven species of *Megaptera*, or humpback: one from Japan, another from New Zealand, and three from the eastern coast of North America, besides *Megaptera longimana* of the North Seas, and *M. versabilis* of the Pacific. The same naturalist enumerates sixteen species of fin-backs.

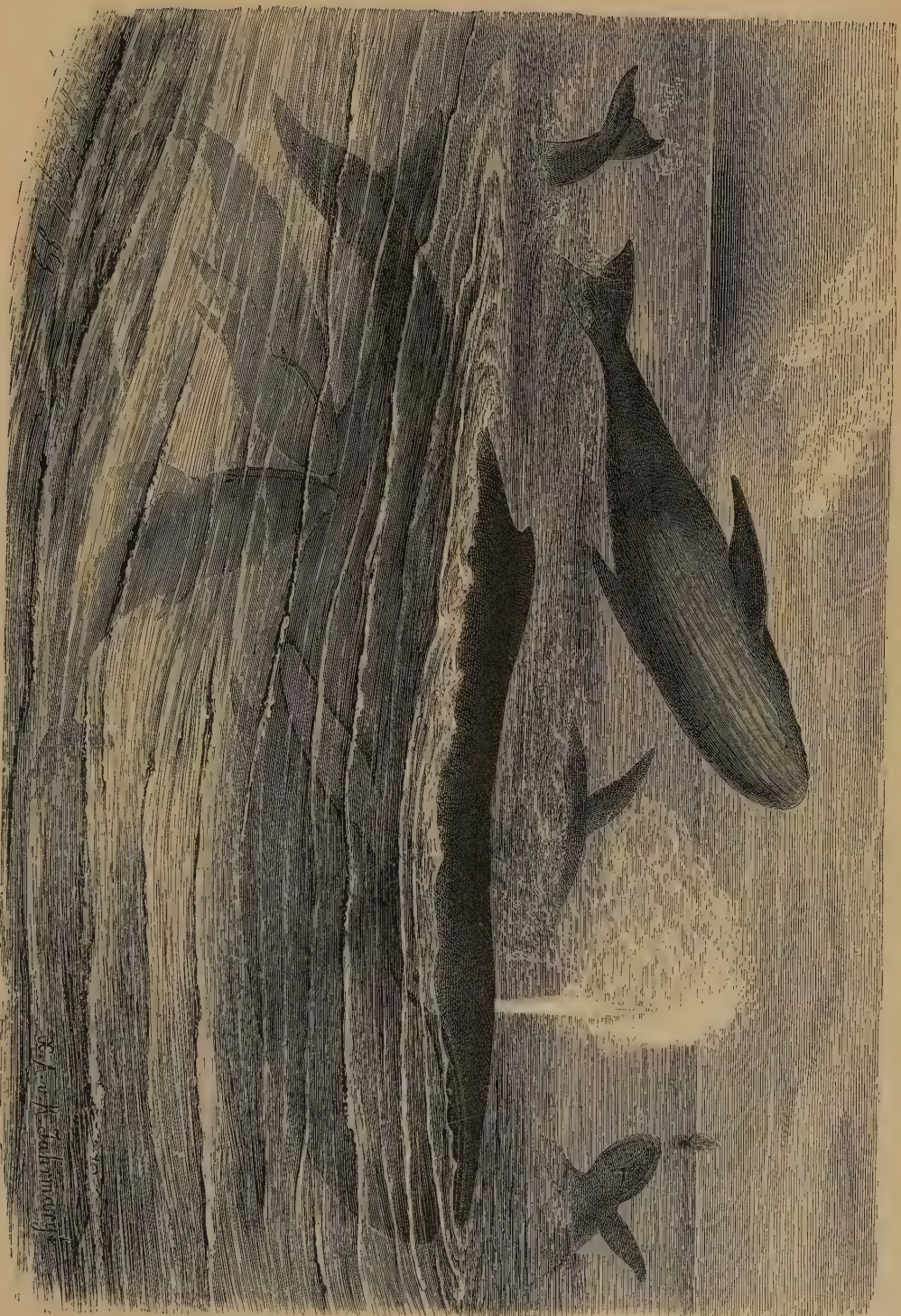
The California Gray Whale, *Rhachianectes glaucus*, frequents the western shores of the United States from October to May, and during the winter, from December to March, the females enter the lagoons upon the coast of Lower California to bring forth their young, the males in the meantime remaining outside. At the end of the season the males occasionally enter the lagoons, and soon after both sexes, with their young,



FIG. 103. — *Balæna cisarctica*, skull showing baleen or whalebone in position.

commence their northward migration, keeping so near the shore that they often pass through the line of kelp that fringes the beach. In the summer they are to be found in the Arctic Ocean and Sea of Okhotsk. In this habit of resorting to shoal bays they differ widely from other whales. In October and November, as well as in the autumn, these whales are passing southwards or northwards along the coasts of California and Oregon, and it is during these seasons that they fall a prey to the whalers of the various stations located along these coasts, at Half-moon Bay, Monterey Bay, Port Harford, Point Conception, and other points.

In size this whale is inferior to the right whales, as the male, which varies more in size than the female, measures from thirty-five to forty-two feet in length, and the female averages forty. The average yield of oil is from twenty to twenty-five barrels; but individuals of larger size, measuring above forty-four feet in length, and yielding sixty to seventy barrels of oil, have occasionally been met with. In color the California gray whale is of a mottled gray, of varying depth, sometimes approaching black.



Megaptera longimana, hump-back, porqual.

W. A. M. Sullivan

The line of the mouth-opening bends downwards, so that the profile of the upper surface of the head is highly convex. Under the throat are two longitudinal folds, about fifteen inches apart and six feet long. The baleen is short, and of a light color, so that it is of little value — the longest blades, out of a hundred and eighty-three in each upper jaw of a male forty-two feet long, were only eighteen inches in length. Its most southern habitat on the American coast appears to be 20° north, but its range on the Asiatic coast is not known, although it is reported to occur along the coast of China. Captain Scammon believes that the female propagates only once in two years.

The shore-whaling fisheries, for the capture of this whale as it passed upward or downward along the coast, were established in 1851, and it has been estimated that for several seasons after this the number of whales that passed southward daily from the 15th of December to the 1st of February was at least a thousand, or about 47,000 in all, without reckoning those which were out of sight of land. But the sagacious whales have now not only learned to keep at a distance from a whaleboat, but to keep much further out to sea, and Captain Scammon estimates the number now annually passing along the coast at only eight to ten thousand in the same time. The shores are strewn with its jaws, vertebræ, and ribs, and it is to be feared that ere long it may become extinct.

The gray whale has received many curious titles, such as "hard-head," "mussel-digger," "devil-fish," and "gray-back." The first name refers to its propensity to upset the boats of the whalers with its head, the second to its habit of descending to the soft bottoms, whence it returns with head and lips besmeared with ooze. Captain Scammon believes that mussels have been found in the stomach of this whale, but states that those taken in the lagoons (during the breeding season) contained only vegetable remains.

The mothers show the greatest affection for their young, and appear, while their cubs are young and tender, to seek the shallowest inland waters, in which they can barely float. The gray whale shows a greater power of resistance and tenacity of life than most other baleen whales, and its capture is frequently attended with loss of life, both to white and red-skinned whalers.

When sporting, these whales raise their huge forms half out of the water, and fall over heavily on their sides, — in the breakers, turning over and over after the manner of seals, — or spring clear out of the water in the wildness of their fun. The California gray is infested with a small crustacean of the genus *Cyamus* (*Anglicé*, "whale-louse"), about three-quarters of an inch long. This occurs in vast numbers, and the species (*C. scammoni*) appears to be peculiar to this whale. Another parasite is a flat barnacle, about an inch and two-thirds across (*Cryptolepas rhachianecti*).

Several species of humpback whales have been described from peculiarities in the osseous structure; but the habits and general appearance of all are so similar that, in the want of any sufficient evidence to the contrary, it is best to consider all those of the northern hemisphere as belonging to but one species, *Megaptera versabilis*. The form of the humpback has none of the symmetry of that of the California gray; the body is short and thick, the profile of the head concave from blow-holes to snout, the lower jaw round and projecting, the pectorals and flukes greatly developed, and the outline of the back broken by a protuberance of varying size and shape, placed about one-fourth the length from the tail-fin. Another lump under the lower jaw, and a number of small ones on the top of the head joined with the bunches of pendent barnacles and the eccentric shape, make one of the ugliest of mammals.

The sexes do not differ much in size, but both vary considerably. Full-grown individuals usually measure from forty-eight to fifty-two feet in length, but the largest taken at Tongataboo (one of the Friendly Islands), in 1871, produced seventy-three barrels of oil, and was judged to be seventy-five feet long. The flipper of an individual forty-eight feet long measured thirteen feet, and the flukes were eighteen feet from tip to tip. The whalebone is of poor quality, and the longest laminæ do not exceed two feet nine inches in length. The skull of an animal of this size would be about fifteen feet in length, the lower jaw about the same, and the largest ribs from nine to twelve feet long on the curve.

The usual color is black, mottled slightly with white or gray on the lower surface, but some are pure white under the fins and about the abdomen, and the posterior edge of the hump is often tipped with pure white.

This whale is much infested by parasites, consisting of large sessile barnacles or *Coronulæ*, sometimes fully three inches across, and a "whale-louse," *Cyamus suffusus*, which occurs in great abundance about the head and pectoral fins, especially in young individuals. The largest barnacles are found on the throat and on the flippers, and attached to them, at least in the humpbacks of the Pacific Ocean, are long pendent barnacles of another species. Though the humpback is found in every sea and ocean at different seasons, and of various stages of growth, observations tend to show that it resorts periodically, and, to some extent, regularly, to certain localities, especially lagoons and inland waters, where the female brings forth her young; and it appears that large numbers of both sexes make a sort of general migration from warmer to colder latitudes as the summer approaches, and back again toward winter.

The irregular course of this whale, and the frequency with which it rounds or rolls, and "turns flukes" in its descent, render it distinguishable at a long distance. The number of respirations it makes on coming to the surface varies from one to as many as fifteen or twenty.

During the mating season the antics of these huge beasts are most amusing. As they lie side by side they administer to each other alternate blows with their long flippers. These love-pats may be heard for miles; and Captain Scammon believes that they have been the origin of the stories current respecting the attack of the whale by the thrasher shark,—a creature incapable of inflicting damage upon such an opponent. These caresses are varied by gambols, the immense creatures "breaching" or springing clear out of the water in their ponderous sport.

While the calf suckles, the mother reclines rather on one side, raising the posterior part of the body nearly out of water. This appears to be the manner of all whalebone whales, and permits two calves to suckle at once. The calves are to be found in the same school or "gam" with the adults.

Individuals of the same school differ greatly in the size of both pectorals and caudal. The latter is scolloped along its posterior edge in some, while the former ranges from its normal long, narrow, and pointed shape to short and broad. Beneath the throat of the humpback are from twenty-one to twenty-six folds, each from four to six inches wide; some of these cross each other or terminate near the pectorals, while others extend farther back. These gular folds, found in this and other rorquals, are supposed by their expansion and contraction to allow the stomach to dilate or contract according to its contents.

The Sulphur-bottom, *Sibbaldius sulfureus*, is unquestionably the largest of the entire class, the hugest of existing mammals, and probably the superior in size of

every other creature, living or extinct, that has ever breathed upon the surface of the globe. On account of its great strength and the rapidity of its motions, as well as of its comparative worthlessness as a producer of oil and baleen, the sulphur-bottom has but seldom fallen into the hands of whalers, and accurate measurements are not easy to obtain. Captain Scammon gives the following particulars of one individual: Length, 95 feet; length of jawbone, 21 feet; length of longest baleen, 4 feet; girth, 39 feet; weight of baleen, 800 pounds; yield of oil, 110 barrels; weight of the whole animal (calculated), 147 tons. Its body is slender, and the pectorals small, short, and rounded at the end, much resembling those of the sperm whale. It has a dorsal fin, situated farther back, and comparatively smaller than in the genus *Balenoptera*. The color of the upper surfaces is light-blackish, sometimes light-brown or almost white, while the under parts are of a yellowish or sulphur tint. Numerous longitudinal folds occupy the anterior part of the lower surface. The baleen is very broad at its base, and of a jet black or bluish tint.

The enormous size and weight of a sulphur-bottom whale may be understood from the fact that in the attempt to roll upon the beach an individual ninety-two feet long that had been taken at Monterey, the capstan, which had lifted many a large whale, was torn up, the falls parted, and the body fell back into the water, where the whalemens were content to leave it, cutting off only that part of the blubber which was above the surface. An individual eighty-five feet long yielded ninety barrels of oil. The introduction of the bomb-gun occasionally enables the whalemens to slaughter, though not always to obtain possession of, these magnificent animals.

The sulphur-bottom is found at all seasons on the coast of Upper and Lower California, and from the beginning of May to the end of September often occurs in large numbers close in-shore. It often follows ships, though it does not play about them so boldly as the fin-back does. A sulphur-bottom whale followed the ship "Plymouth" for twenty-four days during her voyage from San Francisco to Realejo, Central America, keeping near and often passing underneath the keel. Various methods were resorted to at first to induce him to leave; gentle persuasion in the shape of rifle-shots, billets of wood, and bottles were wasted on him, breaking his skin, but not causing him to part company. Finally, as he did no damage and apparently had no intention of doing any, he was allowed to stay, and remained till the water grew too shoal for his taste. The white paint of the ship was badly stained by the impurities of his breath, and his back was much scratched from contact with the ship's coppering, as well as sore from bullet-wounds. The sulphur-bottom rarely "bolts," as the whalemens term the action of leaping out of the water diagonally, or "breaches," as a more perpendicular spring is called, but the sight he presents when he does indulge in such tremendous sport is one not to be readily forgotten.

From the description and figure given by Professor Turner of the Silver-bottom of the Atlantic Ocean, it must be very nearly allied to the sulphur-bottom of the Pacific. The silver-bottom has, on various occasions, been stranded upon the coast of Great Britain. A female, about seventy-nine feet long, that was examined a few years ago by Professor Turner, was found to possess three hundred and seventy baleen-plates on each side of the mouth, the largest of which measured one and a half feet in width at the base, yet fell short of three feet in length. The skin, which was of a steel-gray tint on the upper parts, and silvery below, was everywhere delicate when compared with that of the Greenland whale, as it did not exceed one-fifth of an inch in thickness. Some idea of the vast size of the creature may be derived from comparing it with

those of the full-grown fœtus contained within it. The latter was nineteen and a half feet long, or twice the length of a large ox, yet four such babies, placed end to end, would scarcely equal the mother in length. The mamnæ of the adult extended along nearly eight feet of the ventral surface.

The Razor-back, *Balenoptera musculus*, is one of the largest of whales, the silver bottom and sulphur-bottom alone exceeding it in length. From these it differs in having a more pointed beak, rapidly contracting to its tip instead of curving gently; flippers that are shorter relatively to the size of the body; shorter and narrower baleen,

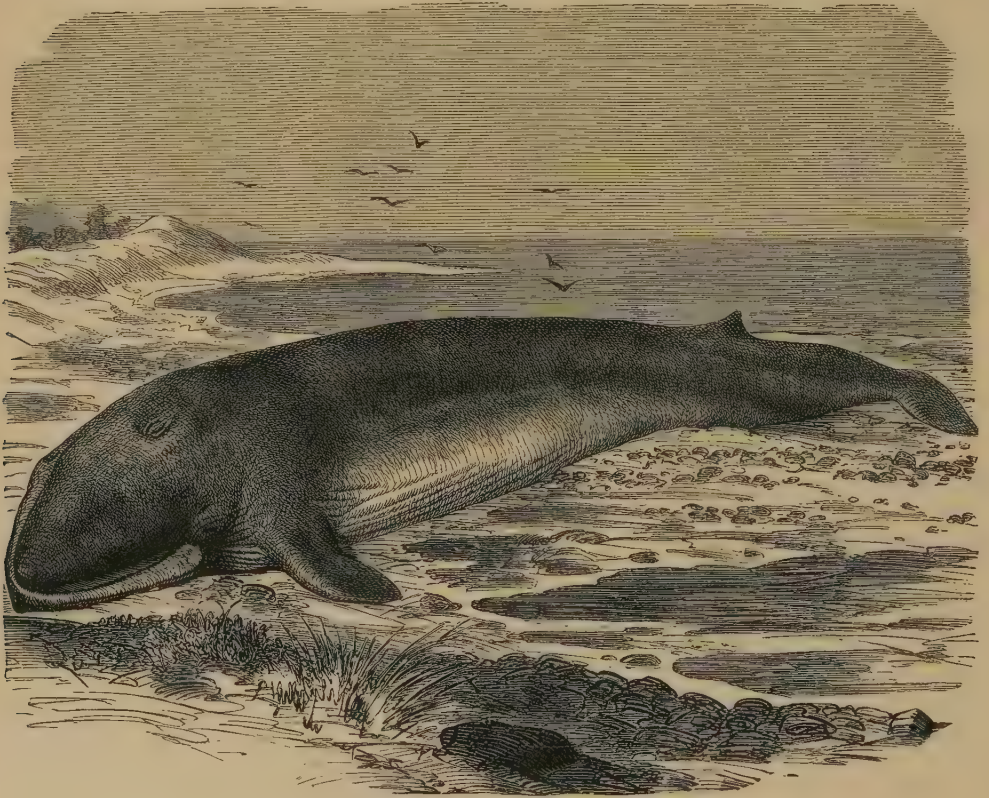


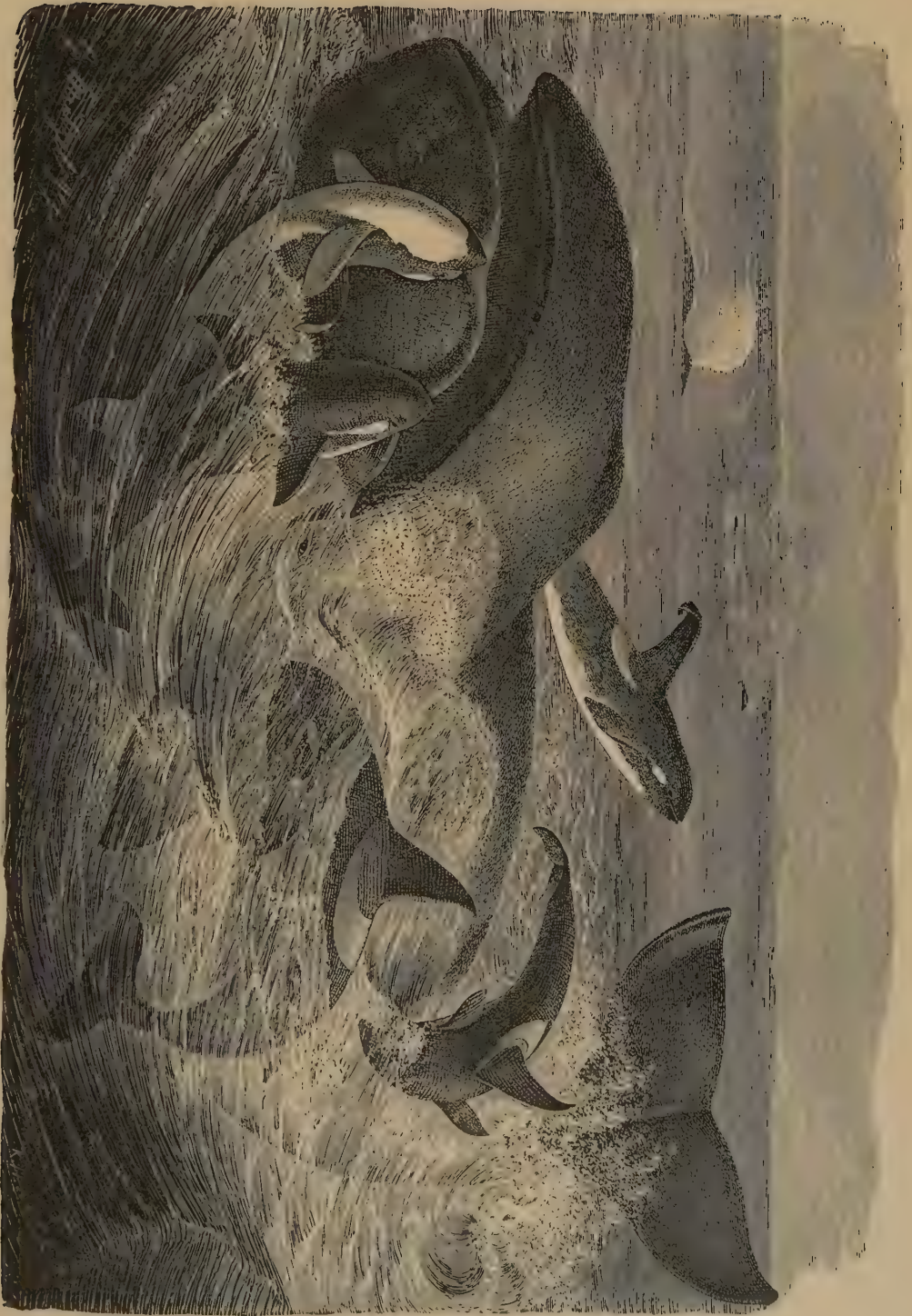
FIG. 109.—*Balenoptera musculus*, razor-back whale.

of a slate color or striped with yellow, white, or brown, instead of rich deep black; and, finally, in its smaller size. Large examples attain upwards of sixty-seven feet, but it is doubtful if it ever exceeds seventy feet. In color it is black above and white beneath. The blubber is not so thick as that of the silver-bottom, so that it yields a much less quantity of oil, and the vertebræ are sixty-one in number, against sixty-four in the former species. The razor-back is an Atlantic species, and occasionally wanders into the comparatively shallow channel that divides England from France.

The Atlantic and Pacific are inhabited, respectively, by *B. rostrata* and *B. davidsoni*, two fin-back whales of small size, not exceeding twenty-five to thirty feet in length.

The Pacific representative of the razor-back is *B. velifera*, which yields in swiftness to the sulphur-bottom only, and is black or blackish-brown above and milky-white

Botanus mysticete, Greenland whale, attacked by *Orca ater*, the black killer.



below. It reaches a length of sixty feet or more, and the width across flukes is about one-fourth of the total length.

The BALÆNIDÆ are distinguished from the fin-whales and their allies by the immense size of the head, the absence of a dorsal, and of folds upon the throat; the shortness and stoutness of the arm-bones; the co-ossification of all the vertebræ of the neck into a single bone; and the length and slenderness of the baleen. Gray enumerates fourteen species.

The Bowhead, *Balaena mysticetus*, so called from the great size and rounded outline of the head, — as its other names, the Greenland whale, polar whale, are derived from the arctic realms, which it inhabits, — is the species which has been longest and most persistently hunted on the coasts of northern America, Europe, and Asia, and is, individually and collectively, by far the most valuable to man of all the Cetacea. Though not the largest of the order, — since it rarely attains a length of sixty-five feet, and fifty feet is rather over the average, — it surpasses every other species both in quantity of oil and length, quantity, and quality of whalebone, — a large example yielding two hundred and seventy-five barrels of the former and a ton and three-quarters of the latter. On account of the great convexity of both the upper and the lower jaws, the space between them gives room in the central portion of its length for plates of baleen sometimes exceeding fourteen feet in length. The total number of plates on each side of each jaw varies from three hundred and thirty to three hundred and seventy. The largest plates have a width of a foot or more, and the fringe of free fibres along their margin is from one to two feet long.

The blubber of an animal forty-seven feet long averaged eleven inches in thickness, and reached sixteen inches where thickest; the blow-holes of the same individual were a foot in length; the black skin upon the back an inch in thickness, and the “flukes” or lobes of the tail nineteen feet in extent.

In form the Greenland whale is the most ungraceful of mammals. Short and thick, with a head fully one-third of the total length, and exceeding in height and thickness any part of the body, a huge mouth of curved outline extending far behind the blow-holes, little pig-like eyes, and short, heavy pectorals, it presents a picture of ungainliness that it would be difficult to surpass. Small though the eyes are, they are really four times the size of those of an ox. They are placed a foot behind the end of the huge mouth. The opening of the ears is not above a quarter of an inch across, and is often so small that it is difficult to find.

The smaller and middle-sized bowheads are black, but the very largest and oldest are of a brown color. All have more or less white upon the under parts, especially about the throat and fins. This whale is comparatively free from parasitic Crustacea, but a few *Cyami*, of a species distinct from that of the humpback, California gray, or *B. sieboldii* occur on the head and fins.

In pursuit of its prey, which consists of the minute Crustacea and surface molluscs, principally Pteropoda, that swarm in the Arctic Seas, the *mysticetus* swims with open mouth at or near the surface until a sufficient quantity of food has been gathered to make a mouthful for a gullet that is not, spite of the creature's size, more than about two inches across. It then elevates its head, allows the water to escape between the fringes of the baleen, and, probably, by the action of the huge mass of fat and flesh that constitutes its tongue, gathers the particles together, and propels them toward its cesophagus. Millions of living beings, each so small that a microscope is needed to

make out its structure, go to form a single swallow; yet some idea of the countless billions of the tiny Entomostraca may be conceived if we remember that they are sufficient to sustain, without diminution in numbers, the hosts of mighty *mysticeti*, as well as myriads of fishes. When the whale descends below the surface its stay is usually from ten to twenty minutes, and it needs from one and a half to two and a half minutes to oxygenate its blood upon its return. During this interval it spouts from six to nine times. What depth it is capable of descending to is not known, as it is usually taken in water of from fifty to a hundred fathoms in depth. Individuals have been known to take out a mile of rope when struck, but as the rope continues to run during the return as well as during the descent the depth can only be guessed at. When the bottom is soft, a stricken whale has been known to stay an hour below the surface, and one struck by the crew of Captain Comstock stayed down an hour and twenty minutes, returning covered with mud, and so exhausted that a single lance-thrust finished it.

Like the humpback, the bowhead is irregular in its movements, and in the periods of time which it spends below and above water. When it moves along the surface, only two portions are visible; these are the protuberance on the top of the head, crowned by the blow-holes, and in advance of the eyes; and the swell of the back midway between this and the tail.

This species is truly an "ice-whale," having its home and feeding-grounds among the floes and fields of the arctic regions, and never venturing in summer south of the districts where ice-fields form in the winter; that is, in the Pacific Ocean, 54° to 55° N. latitude.

The breeding-places of the bowhead are not certainly known, except that the vicinity of Tchantar Bay, in the Okhotsk Sea, is known to be one. Probably the remote line of open water beyond Point Barrow, on the northern shore of North America, is the breeding-ground both of the this species and of the rorquals. In the Okhotsk Sea some smaller whales, called "poggies," and believed by Scammon to be the partially-grown young of this species, are found.

A variety of the bowhead has upon the tapering hinder part of the body or "small" a bunch or hump some two or three feet long and six inches high, a diminutive representative of the dorsal fin of the rorquals. These "bunch-backs" are said to yield more baleen proportionally to the oil than other whales.

The Right Whale of the Northwest, *B. sieboldii*, very much resembles the polar whale, but can be distinguished from it at a glance by the invariable presence upon the end of the upper jaw of a large, rough wart-like protuberance, known as the "bonnet." The upper surface of the head is less convex than in the polar whale, and is more or less corrugated transversely, while both lips and head have some smaller wart-like bunches. These rough surfaces are often infested with parasitic Crustacea. The length of an adult is about sixty feet, — occasionally it reaches seventy, — and there is but little difference in size between the sexes. The usual color is black, but many have more or less white about the throat and pectorals, and some are pied all over. In former times this whale ranged southward to Oregon, and stragglers were taken on the Californian coast, and even as far south as Cerros Island, in 29° north latitude; but their chief resort on the American coast was the "Kodiak ground," or the area from Vancouver's Island to the Aleutians, and westward to 150° west longitude. They congregate abundantly in the southern part of Behring Sea and in the Sea of Okhotsk. The baleen is large, but shorter, coarser, and less flexible than that of the bowhead. The average product of oil is about a hundred and thirty barrels, but some

have yielded as much as two hundred and eighty. The weight of baleen is from a thousand to fifteen hundred pounds.

On account of variations in the form and structure of the shoulder-blades, ear-bones, cervical vertebræ, and ribs, the old genus *Balæna* has been divided into several genera. How many species there may be is not yet definitely known, nor, in view of the great range of individual difference in the skeletal structure, can the genera be considered well established, though the species resting on form, size, color, habits, and habitat may be considered as having become distinct. Among these whales is the New Zealand Right Whale (*B. australiensis*), the Biscay Whale (*B. cisarctica*), once so persistently persecuted by the Biscayan whalers, Macleay's Whale, another southern species, the Cape Whale (*B. antipodarum*), still chased in the waters around South Africa, and *B. australis* and *B. temminckii*, both from the southern seas.



FIG. 110. — *Balæna cisarctica*, Biscay whale.

The species of whale which is not uncommon on the northeast coast of this country, and is even now occasionally seen in New York harbor, the Delaware River, and upon the coast of Maryland, is, according to Cope, identical with the Biscay whale. The skeleton of a half-grown individual, thirty-one and a half feet long, occupies a prominent place in the museum of the Philadelphia Academy of Sciences. William Penn, in a letter dated 1683, states that eleven were taken in that year at the mouth of the Delaware, so that at that time they must have been tolerably abundant; indeed, it is almost certain that the whale pursued by the fishermen of New England, in early days, was this species. *Balæna cisarctica* has now, thanks to the respite afforded it, increased in numbers sufficiently to become again an object of chase to a certain extent. To this group belongs also the Pigmy Right Whale (*Neobalæna marginata*), or Scrag Whale, of New Zealand and Western Australia, an animal which does not exceed fifteen or sixteen feet long, and has whalebone of the most elastic, flexible, and tough character of any living species.

SUB-ORDER III. — PHOCODONTIA.

The Phocodontia are a singular group of mammals of the tertiary epoch, comprising the genera *Zeuglodon*, *Squalodon*, and *Phocodon*. In some respects they appear to unite the Cetacea with the aquatic Carnivora and the Sirenia. The vertebræ of the neck are separate, as in ordinary mammals, while those of the caudal region have their transverse processes perforated, as is the case in many Cetacea. The skull is symmetrical; the nasal bones, though short, are longer than in any living cetacean;

the zygomatic arches are large and thick; and the upper portions of the frontals are expanded. The molar teeth are like those of many seals, having laterally compressed crowns with serrated edges, and two fangs. The first specimen of this group was obtained in the miocene of Malta as early as 1747, and since that period various species have been discovered in this country, in France, England, Holland, Italy, etc. The skeleton of *Zeuglodon*, from the miocene of Alabama, is about seventy feet long, and has a very long and narrow skull. The molars are two-lobed. Some of its teeth have vertical successors,—a character which does not occur in other Cetacea. In *Squalodon*, a species of which is found in New Jersey, the molars have numerous cusps, and greatly resemble the teeth of some sharks.

THE WHALE FISHERY.

In ordinary conversation and whalers' parlance the pursuit and capture of the whale is always spoken of as a fishery, and it appears unlikely that the spread of correct knowledge will correct the name. It is impossible to say when the whale was first successfully chased by man; for Indians, Eskimos, and other aborigines have chased it for ages, with the same primitive appliances that they still use, and the Japanese and Tartars, as far back as we have information respecting them, pursued the whale in large boats.

That the Norwegians engaged early in this fishery we have the authority of "Oh-there, the old sea-captain," a Fleming, who, in A. D. 887, sailed along the Norwegian coast, to use his own words to Alfred the Great, "as far north as whale-hunters used to travel." But all these peoples, though they engaged in the chase of the whale, do not appear to have ever made of it a regular commercial pursuit.

The weight of authority gives to the Biscayans the credit of being the first people who engaged in the business extensively in order to profit by the sale of the oil, baleen, etc. In the thirteenth and two following centuries the natives of Gascony and the Basque Provinces had numerous vessels employed in the Bay of Biscay and adjoining waters, where whales were at that time abundant. The ports of Biarritz, Cibourre, Rochelle, and others, to which whaling seems now quite foreign, were then the centre of a busy trade in whale's tongues (then thought a great delicacy), oil, and baleen, which then, as until very recently, was used to stiffen the framework fashion has thrown around the female form.

The fishery of the Biscayans came to an end, as has that of some other nations, from want of whales; and as the Biscayans were not sufficiently adventurous to go further north, except as sailors in the employ of other peoples, the leading part in this game of slaughter fell to the share of the Dutch, to whom, when the polar seas were parcelled out in districts between the Muscovy Company (English), the Dutch, French, etc., Spitzbergen and the neighboring waters were allotted. Upon the shores of this desolate island, far within the Arctic circle, the important settlement of Smeerenberg sprang into existence. Bowheads abounded in the adjacent ocean, and the most convenient system was found to be to "try" or melt the blubber on shore. The trying-houses were at Smeerenberg, which was founded at the same time with Batavia, and was then of at least equal importance. Not only were boilers, tanks, and all necessary apparatus to be found here, but buildings of various kinds, houses, inns, shops, etc.,—all made in Holland. The whale-ships were attended by provision-ships, and the sailors could even enjoy "hot rolls for breakfast."

But whales became scarce, the scene of the fishery shifted to East Greenland, whither the persecuted animals had retired, and Smeerenberg ceased to be; for the blubber was sent direct to Holland. In 1680 the Dutch had two hundred and sixty ships and fourteen thousand sailors engaged in the pursuit.

Next to the Dutch the English were the most prominent of European nations in the whale-fishery, but a new competitor entered in the race, and soon distanced all others. The chase of the whale was among the first pursuits of the colonists of New York and Delaware, and was at the same time carried on by the New Englanders. In the seventeenth century the whaling was done in boats sent from the shore, as is now practised in California; for the huge game had not yet grown timid. At Nantucket a tall spar was erected, up which a man climbed to watch for whales, and the captured prize was towed ashore and "tryed."

About the middle of the eighteenth century the whales, driven away from the shore, were pursued seawards in sloops and schooners of about fifty tons, with a crew of thirteen men and two boys. Earlier in the century sloops from Nantucket, with two boats and twelve or thirteen men, many of whom were Indians, ventured to Newfoundland and the Gulf Stream, and about 1750 the distant fishery was prosecuted with vessels of as much as 130 tons.

New Bedford, destined to become the metropolis of the American whale-fishery, entered upon the business about 1755. In 1765 Boston had a hundred small vessels. Between 1771 and 1775 there were employed in the northern whale-fishery 183 ships, with a tonnage of 13,820, and 121 vessels, of 14,020 tons, in the southern whale-fishery.

Scammon gives an engraving, from a picture by W. H. Wall, of a whaling scene at New Bedford in 1763. To the right are the sheds containing the trying-pots, with a pair of whale's jaws upon the roof; on the right foreground is a man pouring oil from a ladle into a barrel, while near him another is handling the lumps of blubber; nearer the centre is a group consisting of an Indian and two white men, one of whom has stopped in his task of coopering a barrel in order to converse with the Indian; farther to the left the veteran founder of the New Bedford whale-fishery, John Russell, attired in full Quaker costume, is giving directions to the negro servant, who holds his horse, and in the background are seen the sled used for transport and the whaling-bark, which is drawn up high upon the beach.

Towards the last quarter of the eighteenth century larger vessels were employed, and voyages were made across the equator. The Brazil Banks and the Cape Verde Islands, the West Indies, and the Gulf of Mexico were traversed for cachalots, humpbacks, etc., and the fishery was assuming large proportions when the breaking out of the Revolutionary War entirely paralyzed it. At this epoch many Nantucket whalers transferred their interests to England, and some even to France. The first whale-ship that ventured into the Pacific was sent from England in 1787, and was manned by Nantucket men. In 1791 six vessels, and in 1820 a hundred, chased the cachalots in the newly-discovered grounds off Chili and Peru as far as the Galapagos, and between 5° and 10° south latitude and 105° and 125° west longitude. In 1828 four ships were sent to the eastern coast of Africa, and one of these penetrated into the Red Sea.

The "Kodiak Ground," in the vast bend of the Alaskan coast, which deflects the Karo Siwo southward, was discovered in 1835. In 1839 the American whale-fishery had more than recovered from its temporary decline, and boasted of a fleet of 557

vessels. In 1842 this number had increased to 652, while at the same date the total number of foreign vessels engaged in the same business was only 230. In 1846 seventy thousand people lived, directly or indirectly, upon the receipts of this industry; the value of the vessels engaged in it was above twenty-one millions of dollars, and the investments of every kind reached a total of seventy millions. At this date the whaling fleet consisted of 678 ships and barks, 35 brigs, and 22 schooners, — 233,189 tons in all. Soon after this date the fishery began to decline, and is now, even with the addition of the few ships owned in San Francisco, far less important than formerly.

The ships now employed are from three to five hundred tons, and are, when prepared for a three years' voyage, worth from thirty to sixty thousand dollars. Such vessels lower four boats with five oars each, have two or three boats in reserve, are furnished with patent purchase windlass for raising the blubber, and have try-works with portable pipes which carry the smoke clear of the decks, thus getting rid of the grime and soot which formerly disfigured the ship. Over a thousand separate articles are required to complete the outfit of a whaling-ship. The entire company of a four-boat whaler consists of thirty-five persons at least, namely: captain, four mates, a cooper, a carpenter, a steward, four boat-steerers, a cook, and twenty-two men and boys. All are shipped "on a lay"; that is, on a share of the profits.

The crew of each boat consists of a mate, who is the "boat-header," a boat-steerer, and four men, who are selected for strength and endurance. The rest of the crew, who remain in the ship, are called ship-keepers. The principal ship-keeper is the captain himself, who now usually takes no part in the active chase of the game.

A modern whaleboat is twenty-eight to thirty feet in length, and six feet in width; is sharp at both ends, has sloping sides, and is an excellent sea-boat. At the bow is a groove, called the chocks, in which is placed a metal sheave for the line to run in. The line is kept in the groove by a pin of tough wood or baleen that passes through holes above the line. The boat carries a supply of these pins. Three feet from the stern is the "clumsy-cleat," a short thwart with a rounded notch behind, against which the boat-steerer braces himself by one leg when a rough sea or a whale makes it necessary. A sort of a deck, six inches below the gunwale, on which the first portion of the line is coiled, is called the box. Five thwarts cross the boat, and opposite each rowlock, near the bottom of the boat, is a cleat which receives the handle of the oar, raising the blade high from the water when the crew are resting or when fast to a whale. Four feet of the stern are decked over, and through this, but a little to one side, projects the "loggerhead," a post with a large head, around which the line is passed.

The total number of articles needed in a whaleboat is forty-eight, including oars, paddles, rowlocks, five harpoons, one or two tubs to hold the line, a mast and yard or sprit, one to three sails, three hand-lances, three short warps or coils of rope, a boat spade, three lance-warps (to secure the lances), one boat-warp, a boat-hatchet, two boat-knives, one boat-waif or flag, a compass, a boat-hook, a drag, a grapnel, an anchor, a sweeping-line, with its lead and buoy, etc., a boat-log, a boat-bucket, a boat-crotch for support of harpoons when ready for use, six chock-pins, a roll of canvas, two nippers, a bomb-gun, and four bomb-lances. To these is sometimes added a Gruner's harpoon gun, which is quite successful in a smooth sea, projecting a harpoon four and a half feet long to a distance of eighty-four yards. It is fired by the boat-header. The nippers are made of several layers of canvas stitched together, and are used for holding on to the line when it is running out too swiftly; and the bomb-gun, with its lances, is

employed to kill the whale when beyond the reach of the hand-lance. It will do good work up to twenty-five yards.

While engaged in whaling, all hands breakfast at sunrise, and watches are set at each masthead, and relieved every two hours, as is the man at the wheel. If no whales are seen, the watches are called in at sunset, and a night-watch set; but if whales have been captured the hours are regulated by the work. When a whale is seen spouting, the cry is, "There she blows!" When the watch at the masthead sees the whale spring from the water, he cries, "There she breaches!" When he sees the tail disappear in a downward plunge, he shouts, "There goes flukes!" Then comes the question, "Where away?" and the answer, "Right ahead!" or, "On the beam!" and at once the chase is entered upon. The boats are lowered, the line from the line-tub is passed round the loggerhead, then forward over the oars, and a few fathoms are coiled up on the box of the boat. Two harpoons are placed in the head of the boat, their staves resting on the boat-crotch, and the box-warp is made fast to one of them, while the second is connected to the main line by a short warp or line. The lances are laid on the starboard side of the bow, the boat-spade opposite, the boat-hatchet and a knife ready — the other knife in the stern.

The officer in charge sits in the stern and steers, while the boat-steerer pulls the first oar. The whale is approached cautiously, in order not to alarm or "gally" him; the paddles are used whenever it is sufficiently calm, but oars are resorted to when necessary. When about three fathoms from the whale the boat-steerer, who is also the harpooner, is ordered to "stand up." Instantly he springs to his feet, seizes the harpoon, darts it into the whale, and, if possible, throws the second harpoon before the creature is out of reach. The moment the whale is struck the order, "Stern all!" is given, and the oarsmen strain every muscle to back away from the animal, to avoid being staved in by a blow of its tail as it swings it around in its agony. In spite of all their efforts the boat is often injured, and if the injury is serious the line is cut, or let go with a drag or buoy attached. The nearest boat then continues the pursuit, while the next one pulls for the disabled boat and rescues the crew. The moment the whale is fast the boat-steerer changes ends with the boat-header and steers, while the officer attends to killing the whale. If the whale "runs," or keeps upon the surface, every effort is made to get near enough to shoot a bomb or to use the hand-lance; but if it descends, or "sounds," the line is held on to with the nippers, and slacked as slowly as possible. Occasionally the bows are dragged under water by the force of the descent, and sometimes all the available line is taken out almost on the instant, so that it has to be cut to prevent being drawn down, and the whale escapes. At other times the whale "brings to," or remains quiet, so that the boat may be pulled within bomb range.

Each oarsman has his especial place and duties. The "bowman," who is only really bowman after the whale is struck, has to attend to the line as it passes him; the "midship-oarsman" pulls the longest oar; the "tub-oarsman" has to see that the line runs clear from the tub; and the "after-oarsman," who is the lightest of the crew, attends to the line as it is hauled in, and bails the boat. Some ships use Pierce's harpoon bomb-lance gun. This consists of a gun containing a bomb-lance, and fitted to a harpoon, which is thrown by hand. When the harpoon enters, a long steel rod comes in contact with the whale, touches the trigger, and fires the bomb-lance. The concussion produced by the bomb-lance on striking the whale lights a percussion-cap within, fires a time fuse, and explodes the powder inside the body of the animal, usually killing it instantly.

While the boats are engaged in the chase a sharp watch is kept upon them from the maintop-gallant cross-trees, from whence they are signalled. In the right whale fishery the boats usually stay near enough to the ship to communicate with it, but in fair weather the boats engaged in sperm whaling go as far away as ten or twelve miles. If a fog comes on the ship is kept, as far as possible, in the position in which it was last seen from the boats, horns are sounded, guns are fired, and, if the boats are out at night, lights are set, or a fire is made upon the "back arches" of the try-works, producing a grand effect amid Arctic scenery. The boats find their way back by the boat-compass. If there is a breeze when a whale is taken the ship goes to the whale, but if calm, the prize is towed to the ship.

The process of stripping the whale of its coating of fat is a rather complex one, so much so that it is difficult to understand from descriptions. When the whale is alongside the ship the flukes are secured by a chain or rope, and hauled tight. The cutting tackles are then sent aloft to the mainmast-head, and the "cutting-stage" is built over the whale in such a way that, while standing upon it, the officers can use their cutting-spades to sever the blubber from the body. A chain is then placed round one of the pectorals and hauled tight with the tackle, so that the whale now rests secured by tail and flipper. The first piece of blubber taken off is that of the lower lip. A hole is cut in the lower lip near the angle of the mouth, and an incision or "scarf" is carried from the angle downward, curving around and running forward to the end of the jaw. Then a "blubber-hook" is put in the hole, and pulled at by means of the second set of tackles, while a man with a cutting-spade cuts away underneath the huge piece of fat and skin, loosening it from the flesh and bone below, till finally it is free, and is hoisted aboard of the ship. Next a cut is made across the back of the carcass, under the fin, and again across the body, so as to surround a large piece, which is called the "first blanket-piece." This is hauled in by the flipper, which is cut away with it; but before the blanket-piece is severed, and while the carcass is hanging by it, a hole is cut through between the spout-holes, a chain put in, and attachment made to the free tackle. By the use of the tackle that hauled in the first blanket-piece the carcass is turned so that the other lip can be cut off, and by subsequent manœuvrings two more large bands, or "blanket-pieces," are stripped from the front part of the body. Meanwhile the skull is cut across with axes, and the entire upper jaw, with the baleen attached, is hauled on deck by means of the chain reeved through the spout-holes. Then the blubber left upon the body is cut into spiral folds and rolled back behind the vent, at which spot the carcass is cut through, the backbone disjointed, and the mass of flesh and bone that has been denuded of its covering is allowed to float away or sink. Then the "small," or tail portion, is stripped, the flukes cut off close to the chain, and the fluke-chain hauled in. The body being now got rid of, the next proceeding is to cut the baleen, with the gum attached, from the skull, with axes and cutting-spades, and stow it away below. In fine weather, when there is leisure, the slabs are separated, the gum scraped off, and the clean laminæ dried and packed in bundles.

The body of a sperm whale undergoes quite as intricate a series of turnings as that of a right whale, and is even made to assume a perpendicular position. As the most valuable and most abundant deposit of oil in this whale is to be found above the skull, the process necessarily differs in its details from that employed upon a baleen whale. While the body depends from a chain reeved through a hole above the angle of the mouth a cut is made along the head, roughly corresponding to the line of the upper



Cutting up the whale.

surface of the maxillary, and thus separating the "junk" from the jaw. If the whale is large, another cut is made higher up, at the line of union between the junk and the case. Next an incision is carried over the head. The whale is then turned

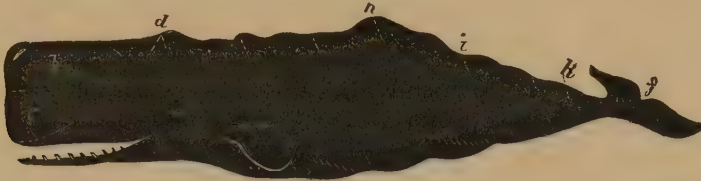


FIG. 111.—Outline of sperm whale, illustrating whaler's terms. *b.* Situation of the case. *c.* Junk. *d.* Bunch of the neck. *h.* Hump. *i.* Ridge. *k.* The small. *f.* Flukes. Between the dotted lines are the spiral strips or blanket-pieces in which the blubber is taken off.

over by hauling at the attachment on the side, and the jaw is wrenched away. Then a chain is attached to the anterior portion of the head, the fluke chain is lengthened, and, while the body thus hangs almost vertically, the entire mass of junk and case is cut away from the bone below, hauled up, and made fast. The blanket-pieces are then stripped from the body as in a whalebone whale, the backbone disjoined, the larger part of the carcass allowed to sink or float away, and the blubber and "small" hoisted on board. The "case" is then opened, and the contents bailed out with the case-bucket.

The blubber is "tryed," or melted, on board ship, after it has been cut into pieces of suitable size.

The principal regions or "grounds" for sperm whaling are the Azores, or Western Islands, the Cape de Verde Islands, the Charleston grounds, north of the Bahamas, the Gulf of Mexico and the Carribbean Sea, and the Carrol ground, between St. Helena and Africa; also in the Indian Ocean, the Straits of Madagascar and the northern end of that island, the coast of Arabia, Java, the Straits of Malacca, and the northwest and southern coasts of Australia. In the Pacific Ocean the sperm whale fishery is carried on off Cape Horn, along the coast of Chili and Peru, around the Fiji, Navigator, and Kingsmill Islands; across the South Pacific between 21° and 27° S. lat.; across the North Pacific between 27° and 35° N. lat., off the eastern shore of New Zealand, on the Middle Ground, between Australia and New Zealand, in the Sooloo and China Seas, along the coast of Japan, and between it and the Bonin Islands, and along the California coast.

The whaling-grounds for whalebone whales are, in the North Atlantic, from the Bahamas to Newfoundland, Hudson's and Baffin's Bay, Davis' Straits, and the coasts of Greenland and Spitzbergen; in the South Atlantic, the Brazil Banks, Patagonia, and the Falkland Islands, around Tristan d'Acunha and Gough Islands, and along the coast of Africa; in the Pacific, along the northwest coast of North America, and along the coast of Kamtschatka through Behring Sea into the Arctic, as far as the icy barrier will permit, the Seas of Okhotsk and Japan, the Gulf of Tartary, the southern coast of Chili, and the eastern shore of New Zealand; also around the Crozets, and Kerguelen Islands, south of the Indian Ocean.

ORDER VI.—SIRENIA.

Very like a whale in external appearance are the members of this order, and, indeed, for a long time they were classed with the Cetacea. The next freak of the systematists was to separate them from the whales, and assign them a position near the elephants and ungulates. At present, however, it is thought that the original ideas regarding them are more nearly correct, though all agree that they belong to a distinct order from the whales.

The body in all the sirenians is long and sub-cylindrical, or fusiform, the tail terminating, either like that of the whale with a fluke on either side, or in a flat, broad, rounded paddle. The muzzle is very prominent, and the two nostrils are each provided with valves. The tip of the nose is covered with short bristles, while at the angles of the mouth there is a great development of hair, which is kept in motion when the animal is feeding. The eyes are relatively small, and there are no traces of external ears. The two mammae are situated far forward, close to the armpits. All traces of hind-limbs have disappeared externally, while the anterior pair are large, flat, and flipper-like, and exceedingly flexible. The skin is very thick and tough, and may be either rough, with scattered hairs like that of the elephant, or smooth and hairless like the integument of the whales.

The skull is relatively much smaller than in the whales. The two parietal bones meet above; the orbits are well-defined, and nearly or quite complete. The ramus of the lower jaw is at right-angles to the jaw itself. In *Trichechus* there are only six cervical vertebrae, but in the other genera there are seven. These cervicals are always free, and never ankylosed. The ribs, of which there are from fifteen to nineteen pairs, are very thick and stout. The skeleton of the anterior limbs is well developed, while that of the posterior pair is rudimentary, or entirely absent, and the pelvic girdle, in the living forms, is reduced to a single small bone on either side, of doubtful homology. All of the bones are very dense and heavy, exceeding, in these respects, those of any other mammal. The small brain has but few convolutions, and according to Dr. Chapman is more like that of rodents than like that of the elephant. In *Rhytina* all true teeth are absent, but in the others they are present in varying numbers. In all, the anterior portions of the jaws are covered with curious horny plates, with an undulating surface. The stomach is divided into two large digestive chambers, the first of which bears two appendages, as well as a peculiar gland, shaped like a finger, and beset with follicles. The alimentary tract, like that of all herbivora, is very long, varying from eleven to twenty (in Steller's *Rhytina*) times the length of the body. The trachea is unlike that of the Cetacea, and resembles that of the land Mammalia. The heart is cleft at the apex between the ventricles, so that it presents a double appearance. The lungs are very large, extending in the manatee nearly one-half the length of the body.

Members of this group have been known from ancient times, and have, it is supposed, given rise to the tales of mermaids and mermen. They are slow and inoffensive animals, living solely on vegetable food, and their flesh is said, by those who have partaken of it, to be extremely palatable. But two genera are now living, a third having become extinct about a hundred years ago. The fossil genera belong to rocks of the Cainozoic age.

The first form which we will consider is Steller's *Rhytina*, *Rhytina stelleri*, to which we have referred in the preceding account. When Behring — the celebrated Russian voyager, who gave his name to the straits between Asia and America — was on his second voyage, he visited Kamtschatka and the adjacent Behring's Island. Here there were found numbers of the huge animals, which were even then on the road to extinction, for they were confined to this one island. Steller, who accompanied the expedition as naturalist, has given an account of the anatomy and habits, which until recently have furnished our whole source of information regarding the northern sea-cow. His account in substance describes an animal from twenty to twenty-eight feet in length, with a small oblong head, the snout covered with bristles, the dark-colored body covered by a very rough and thick skin, destitute of hair. The tail was black, ending in a pair of narrow, horizontal flukes, fringed with stiff bristles, closely resembling whalebone.

Though very stupid they were of an affectionate disposition, and the sailors readily tamed them. They fed on sea-weeds, eating with the head beneath the water, and arising at intervals to breathe. The great herds were divided into families, each consisting of a male and female, a half-grown individual and a young one, born in the autumn. The sailors and natives made short work with these animals, the flesh being very good, and far preferable to the salt-meat which is found on shipboard, and the result was that the last *Rhytina* was killed in 1768.

The collection of bones in St. Petersburg, until recently, were the principal specimens of the *Rhytina* in any collection; but in 1883 the Smithsonian Institution received from Dr. L. Stejneger, who visited that region, eleven nearly perfect skulls, and several sets of nearly all the bones of this extinct form.

The palate is covered with a rough horny plate, in which no calcareous salts are deposited, while the lower jaw bears a similar armament; between these plates the seaweed was ground before passing into the stomach. Steller mentions one striking feature. In the fore-limbs there are no bones beyond the wrist-bones, the fingers being entirely lacking.

By the word Dugong the Malays refer to the sirenian known to science as *Halicore dugong*, which is found from the Red Sea, Eastern Africa, and Mauritius to Malacca, the Indian Archipelago, and the West coast of Australia. The color is usually bluish black above, and lighter beneath; the skin is smoother, and the flukes of the tail broader than in *Rhytina*. The fore-limbs are rather long, but are without claws. The dentition is rather peculiar in not being constant; it varies from *i.* $\frac{1}{6}$, *c.* $\frac{8}{6}$, *m.* $\frac{3}{6}$ = 14, to *i.* $\frac{1}{6}$, *c.* $\frac{9}{6}$, *m.* $\frac{5}{6}$ = 22. The incisors in the male are long, but in the female they are almost entirely concealed within the jaw. Occasionally in the young males other incisors are present in both jaws, but they soon disappear. The molars have broad, flat crowns, destitute of enamel, and usually those in front drop out, and those behind succeed to their place as in the Proboscidea. These peculiarities of dentition form one of the chief arguments in favor of placing the sirenians near the elephant and mastodon.

Once the dugongs were very numerous. The early traveller, Leguat, tells of seeing schools of several hundred, grazing like sheep on the seaweeds, a few fathoms deep, in the Mascarene Islands. The flesh is regarded as an especial delicacy, and the Malay king claims, as royal property, all that are taken in his domains. The flesh of the young is compared to pork, beef, and veal; but the old dugongs are tougher, and not so highly prized. A clear oil is obtained from them, which has no disagreeable taste

or odor, and which is highly recommended as a substitute for cod-liver oil. For this reason a dugong fishery has been established in Australia, with the result of rapidly decreasing the numbers of this once common animal.

In their habits they are very slow, and are not naturally timid. They prefer shallow harbors, bays, and mouths of rivers, where they can find sufficient seaweed to supply their enormous appetites.

Only three species of the genus *Trichechus*, or Manatees, are certainly known: *T. senegalensis* from the west coasts of Tropical Africa, *T. americanus* from the eastern coast of the western continent, and a third species from Florida, *T. latirostris*.

The genus is characterized by the dental formula, — $i. \frac{2}{3}, c. \frac{1}{3}, m. \frac{2}{3}$ or $\frac{3}{3} = 36$ or 40. The incisors are present in the upper jaw in the young, but disappear in the adult;



FIG. 112. — *Halicore dugong*, dugong.

while the molars present the same phenomena of dropping out, and a succession from behind that we have noticed with the dugong. The molars have square, transversely fissured, flat crowns. The anterior portions of the jaws are covered with horny plates. The nostrils are provided with semi-lunar, valve-like openings. The upper lip is swollen, and deeply notched in the middle. The eyes are small, and are surrounded with radiating folds of the skin. The forelimbs have five digits, the first being represented by the metacarpals alone, while the others are provided with phalanges, their tips being armed with flat claws. The caudal fin is broad, and its extremity is rounded, the whole presenting some resemblance to the tail of a beaver, though the proportions are somewhat different.

The South American form, *T. americanus*, is the best known species, and a description of its appearance and habits are here given. The skin is of a grayish color,

and closely resembles that of an elephant in texture, the similarity being increased by the presence of scattered hairs. As in the rest of the sirenians these hairs are longer, stouter, and more numerous on the palmar surface of the flippers, and especially at the



FIG. 113.—*Trichechus americanus*, American manatee.

angles of the mouth. The length of the body is usually from twelve to fifteen feet, but, occasionally, old males are said to measure twenty feet in length. This species frequents almost all the rivers of the eastern coast of tropical America, living equally well in salt or fresh water, and ascending the Amazon to Pebas, Equador. It is also found in the West Indies, on the shores of the Gulf of Mexico, and, if the Floridian form be not really a distinct species, it extends to that peninsula as well. In their habits they remind us of the *Rhytina*, forming families, which unite into herds, as described

with that form. They are apparently monogamous, and are very affectionate, and if the female be attacked, the male will not leave her. The intellect, as would be inferred from the small number of cerebral convolutions, is but feebly developed.

In 1875 two small individuals were brought from Demerara, British Guiana, in separate tanks to Baltimore, and thence to the Philadelphia Zoological Gardens, where they lived in confinement for two months and a half. Dr. Chapman has given an account of their habits and structure, which we freely use. One of them measured six feet, and the other six and a half in length. Arrived in Philadelphia the animals were placed in aquaria filled with Schuylkill water, which they seemed greatly to enjoy, swimming about and rolling over and over. They were fed on the plant *Vallisneria*, gathered from the river, which they fanned, as it were, into their mouths by the bristles at the angles of the tips; these hairs spreading out when in use so as to look very much like small fans. When not in motion they rested with the tip of the tail on the floor of the aquarium, back much arched, and the head downward. Breathing took place at intervals of from a minute to a minute and a quarter, the animal rising to the surface for the purpose, and at such times the valves of the nose were seen to open, and then to shut again, as the animal sank.

The manatees are hunted by the Indians of South America for food. A harpoon is used in their capture, and when caught the nostrils are plugged up, and the huge animals die of suffocation. Like the rest of the order the flesh is highly prized, and on the coast of Honduras the tail is placed for several days in a pickle of spices, which is said to add not a little to its taste. Like the halibore the manatee furnishes a very soft, clear oil, which does not become rancid.

The fossil genera are rather numerous, and include six (*Prorastomus*, *Anaplo-nassa*, *Hemicaulodon*, *Ontocetes*, *Dioplotherium*, and *Manatus*) from American beds. The latter genus has left many remains in the more recent strata of our east coast

from Maryland to Florida, vertebræ being comparatively abundant in the eocene beds of the Cooper and Ashley Rivers in South Carolina. The best known fossil genus is *Halitherium*, from the miocene of Europe. In this genus the division of the back teeth into molars and premolars is well-marked, while the upper jaw-bone has tusk-like appendages. This form had also a thigh-bone a few inches in length. In *Prorastomus*, from the West Indies, the dentition was *i.* $\frac{3}{3}$, *c.* $\frac{1}{1}$, *p.* $\frac{5}{5}$, *m.* $\frac{3}{3}$ = 48, which, with the exception of the premolars, reminds one of the tapirs. The genera *Dioplotherium*, with two incisors, from South Carolina, *Ontocetus* from the same State, and *Hemicaulodon*, from the eocene of New Jersey, are but little known.

The line of descent of the Sirenia is very obscure, yet we are inclined to agree with Dr. Gill that it is probable that, together with the whales, they have been derived from some type with separate and spreading toes, which formed, at the same time, the common progenitor of the carnivorous and other Educabilia. In what line of descent this has followed is extremely uncertain. At the most, however, it can be claimed that no quadrupedal type exists, or has left its remains, so far as is yet known, which so nearly fulfils the condition of intervention between the ordinary quadrupeds and the whales and sirenians, as the Pinnipedia.

J. S. KINGSLEY.

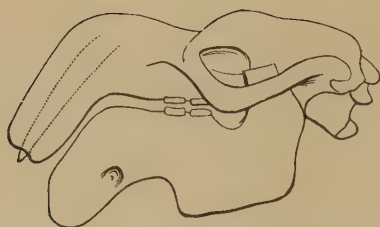


FIG. 114. — Skull of female manatee, showing the enormous tusk which never pierces the fleshy lip.



Elephas africanus, African elephant.

ORDER VII. — PROBOSCIDA.

There are two living species of Elephant, — the African (*Elephas africanus*) and the Indian (*Elephas indicus*). The former was well known to the ancient Romans, and was even domesticated and employed in warfare by the Carthaginians; yet it is only within recent years that specimens of it have been brought to modern Europe, and it is now always found wild. In 1865 a pair were brought to London, which are still living. It differs from the Asiatic form by having excessively large ears, a prominent convex forehead, head hanging downward so as to give an undignified bearing, tusks large in both sexes, and their ivory valuable; natural callosities at the front knees, and horny hoofs, four on the anterior and only three on the posterior feet. (All the feet of all elephants have five toes internally; the Asiatic elephant has four external hoofs on all the feet, while his African cousin has the hoofs of the hind-feet still further reduced to three.) The African elephant, like the human residents of the dark continent, is nearly black. The ridges on his molar teeth enclose lozenge-shaped areas, a pattern differing widely from that of the Indian elephant; for this reason some authorities make a separate genus for him (*Loxodon*). The Indian elephant has a more elevated head, with small ears and flat forehead, the tusks of smaller size, — very small or wanting in females, — the molars with many transverse parallel ridges. It can be reduced to a state of domestication and used as a beast of burden, though it very rarely breeds in captivity.

Remains of the Mammoth (*Elephas primigenius*) were frequently found during the last century in various parts of Siberia, and about the close of the century one was discovered frozen in the estuary of the River Lena, with bones, flesh, and shaggy hair complete. It is said that some of the flesh was eaten by the men who dug it out of the ice. The natives, from superstitious feelings, refused to part with it until bears, wolves, and foxes tore it to pieces, and then Adams was permitted to save the wreck and convey it to St. Petersburg. Existing elephants have short, scanty hair over their rough skin. The mammoth had long, brown hair, ten inches long, with longer black bristles intermingling, and a shaggy mane. The existing species are confined to the tropics (but the Indian elephant sometimes lives, in company with monkeys, near the snows of the Himalaya Mountains); the mammoth, on the other hand, tenanted the temperate and northern parts of both worlds, its remains having been found in the British Isles, France, Central and Northern Europe, Siberia, Alaska, and the parts of North America as far south as Oregon.

All the elephants are remarkable for their large, heavy bodies, supported on four pillar-like limbs, body short, neck very short, and the skull with lofty crown and short face-bones, saving that the premaxillaries are enlarged to form sockets for the long tusks. To compensate for the short neck and face, they are provided with a long proboscis, often four or five feet in length, by which they are able to reach the ground, and which they coil up when it is not in use.

Their large size, precious ivory, and extraordinary proboscis, have rendered them objects of interest from the earliest times. The ancient Egyptians were acquainted with both the African and the Asiatic species. They received tributes of ivory, and sent ivory as tribute to Persia, and called an island in the Nile, in Upper Egypt, Elephantine. The Egyptian monuments show negroes leading tame *African* elephants

(with large ears) into Egypt. Solomon had a throne of ivory, and ivory palaces are referred to in the Psalms. In the Old Testament, and on Assyrian inscriptions, a word (*abba*) is applied to these animals which long puzzled lexicographers, but is now known to be their name in native languages of India and Ceylon.

When Alexander the Great led his Macedonian troops into northern India he was opposed by King Porus, who brought against him horses and chariots and hosts of soldiers and eighty-five elephants; these frightened the Greeks, but did not otherwise hurt them. Antiochus Epiphanes subsequently employed them against the Egyptians. The Greek king, Pyrrhus, brought them with him when he invaded Italy; and Hannibal, with his Punic army, brought African elephants across the Alps, and used them to assist him in subduing the Romans.

We have a relic of still earlier times in a piece of ivory from a mammoth's tusk found (by M. Lartet, in 1864) in Central Europe, having a correct likeness of the extinct mammoth carved on it by human hands; thereby proving that the mammoth was at one time a contemporary of man in Central Europe, that the men of those days, so far from being savages, had somewhat of esthetical taste and skill, and that the big beast had secured their special admiration.

Though the elephants are the largest of land animals, their size is often exaggerated. The height at the shoulders rarely exceeds ten feet, and even the mammoth scarcely surpassed this height. The feet are large and nearly plantigrade, the heel almost reaching the ground, and the rule is found to hold good that twice the circumference of the foot nearly equals the height of the animal. The toes are so enclosed in the thick skin and horny pads as to be immovable on each other. The skin of the whole body is thick, in loose, wrinkled masses, and hence this group formed a section of the old order of *Pachyderms* or thick-skinned animals. The eyes are exceptionally small, so as to give a look of stupidity. The weight of a large individual may reach seven or eight thousand pounds, and their strength is enormous. An elephant can easily carry as large a load as could be placed on sixteen oxen. We find an authentic report of one of them lifting over a height a piece of cannon which had baffled forty-eight oxen. Their immense weight and large feet cause them to leave large, deep tracks in the marshy regions through which they travel; and they usually destroy their enemies by treading upon them, or by pressing them down, or throwing them into the air with their tusks.

By far the most characteristic equipment of these large animals is their trunk or proboscis. It is produced by the union and excessive development of the nose and upper lip. Many other animals, as the small shrew, the tapir, and even the horse, have a more or less fully developed proboscis; and it is believed that many fossil forms were provided with a similar apparatus, specially the *Dinocerata* of the *eoocene* times. The elephant's proboscis is inserted on the nasal opening, which is high up on the face; it has a pair of tubes, which are closed proximally by valves, and open at the distal extremity, where a small, finger-like process overarches them. It is attached by large muscles to the face-bones, and thus is raised or depressed; and it contains a great number of small, transverse, and oblique muscles, which enable it to expand or contract, or turn round in different ways. It differs from the proboscis of certain *Insectivora* in its internal structure. The insectivorous snout is largely constituted by nasal cartilages; whereas the elephant's proboscis is made up of muscular and membranous tissue, the only cartilages being the valves at the entrance of the bony nares. The muscles of the proboscis consist of a superficial set, running longitudinally, some of

them anterior, others posterior, others lateral, and also of a deep set which are radiate and transverse. Cuvier tried to count its muscles, and after having found twenty thousand of them he gave up the task, estimating that there were about twice as many in the entire organ. Externally the proboscis is "ringed" with annular constrictions, producing a kind of segmentation. It serves many purposes, being at once a respiratory organ, and capable of exercising smell, taste, touch, suction, and prehension. It has exquisite sensibility and great power combined. It will uproot trees or gather grass, pick up a lozenge or lift a cannon, brush off a fly or kill a man by catching him around the waist and flinging him to a distance. It seizes food, which it can then put into the mouth; or sucks up water, which it discharges again by turning its tip into the mouth, and so squirting the fluid down its throat; or it can squirt the water over its own body, or over the body of an offending man, and so administer a refreshing bath or a severe chastisement, as the case may be. Its length supplies the want of a long neck, which would be incompatible with the office of supporting the heavy head and tusks. It is interesting to see how a monkey's prehensile tail, the monkey's and the human hand, a bird's beak, and an elephant's proboscis, are all different members specialized for the same function of prehension; but the last surpasses all the others by the multiplicity of functions for which it is competent.

Such an organ requires a corresponding measure of intelligence to direct it; and we need not be surprised to find that the elephant is endowed with a large brain, or to hear anecdotes of his good memory and great understanding. Its brain weighs about ten pounds (three times as much as the human brain), and is much convoluted; but the cerebellum lies very much behind the cerebrum (a fact that goes against the idea of high intelligence). The magnitude and complexity of the muscular machinery will, in some measure, account for the largeness of the brain-substance; and after all, when viewed relatively to the weight of the body, it is inferior to what exists in many other mammals, and immensely inferior to the human brain. The elephant's brain is only one eight-hundredth the weight of its body; our brain is one fortieth the weight of our body. Observation shows the elephant after all to be rather a stupid beast; it is the monkey, the fox, and the crow, which (as Calderwood says) are credited by the Hindoos with brute-cuteness, whilst the highest measure of rationality evinced by the elephant is when he plucks off a branch of a tree, using it as a whisk to drive off the flies that torment him. It seems that he is very much afraid of flies, will take fright at a mouse, and is always timid and suspicious, none of these being traits of a large mind. Tennent reports that the elephant will lie on the ground and weep if anything has excited his grief, and a female in London Zoological Gardens was said to shed tears whenever a young one was removed from her side; but these statements savor too strongly of the story of crocodile-tears to perplex us with the necessity of expounding their psychology. The mere possession of so potent a weapon as the proboscis carries with it the necessity of a corresponding development of rationality sufficient for its management; and the anecdotes of long remembrance of kindnesses and insults, and of appropriate requitals when the opportunity comes, may be accepted without our being compelled to accord the character of high rationality. No one would place the elephant's tricks on a par with those of a well-educated dog.

Elephants are usually gentle in spirit, in their wild state going together in crowds of from twenty-five to one hundred, living in peace with each other, and not disturbing any other kind of animal save in self-defence. One of the herds is a family group, — a patriarchal clan, with all its members united by consanguinity, and admitting no

intruders as adopted members. Any individuals that have got out of the family circle are not re-admitted, but are left to spend the rest of their days as lonely vagrants, soon losing their good temper, and becoming dangerous "rogues." Such rogues in most cases soon come to the end of their career, and hence they are rarely met with. The family troops, led by old males, roam through the forests, wade through marshes, or by wading cross streams so deep that only the tip of the proboscis reaches above the surface, this wonderful organ serving as a respiratory tube for diving. In this way they can cross lakes or rivers, their bodies quite invisible to enemies, and they find their way by scent in a straight course to the opposite bank. They sleep either lying or standing, are tormented by many parasites, and are attended by birds which court them for the sake of hunting after the parasites.

The food of the Indian elephant consists chiefly of shoots of soft-wooded trees (mulberry, fig, bread-fruit); they are particularly fond of the sacred peepul (*Ficus religiosa*), the banyan, and the India-rubber trees, and they consume great quantities of such at a meal. They catch the branches and pull them off with their proboscis, crunch the twigs and leaves with their broad molar teeth, stripping off the milky bark from the larger boughs. They also eat various kinds of grasses, especially the bamboo, a kind of sugar-cane, and gigantic reeds growing in the jungle (one of them for this reason named *Typha elephantina*). Clumps of the grasses are twisted up by their proboscis, are beaten against the legs to free the roots from sand, and are then masticated. The sand still remaining, and the silica forming a constituent of the grasses, serve to keep the molar teeth in order. The Ceylonese elephant largely lives on various kinds of palm. The Siberian mammoth, dwelling in pine-forests, lived on the shoots and needle-leaves of the pine-trees, remains of which were found in the frozen specimen by the Lena. The African elephant is accustomed to eat larger shoots and branches, and its teeth are fitted for a coarser diet than its Asiatic relatives. Although using largely the roots of trees and shrubs, it is also fond of fruits, and especially of an intoxicating fruit of a tree which grows at the Cape. Drummond, in his book on the large game of South Africa, says that they come southward in the fruit season, and retreat to the fastnesses in the interior on the approach of winter. They are fond of the fruit of the unganu tree, which intoxicates them. After eating it they become tipsy, staggering about, playing huge antics, screaming so as to be heard miles off, and not seldom having tremendous fights.

Some authors divide the Asiatic elephants into several species, as the Indian elephant (*Elephas indicus*), the Ceylon elephant (*E. cingalensis*), and the Sumatra elephant (*E. sumatranus*). The Ceylonese elephant is smaller than the Indian, and has very small or no tusks. Not one in a hundred of the Ceylonese have tusks, and the few that possess them are exclusively males. They excel in gentleness and docility, but this may be explained by the absence of offensive armature. The Sumatran elephant is more slender and delicately built, with the proboscis longer and finer than in the Indian form, and its tail has a better supply of bristles at its tip. It likewise excels in intelligence. All these characteristics, however, are unstable, and while recognizing two or three varieties, we may include all the living Asiatic forms under the one species, *E. indicus*. The white elephants of Siam are only an albino variety, specially reserved for royal use.

While the African elephant is only known in modern times as a wild beast, all the Asiatic varieties are domesticated, and form a conspicuous feature of Oriental pageantry.



Elephas indicus, Indian elephant.

Even in Asia they are only partially domesticated, as they do not ordinarily breed in captivity. Hence every individual must be captured, and tamed and educated, most frequently by means of cruel treatment. A trained female elephant (a "koomkie") is used as a decoy to divert the attention of the wild males till their feet are pinioned to a tree, and then the captive is left to rage and struggle, till he is exhausted by exertion and hunger, and submits to his conquerors. In other cases a whole herd, males and females, old and young, are driven into a large pound (a "keddah"), where all kinds of stratagems are used to reduce and secure them. Sometimes they are trapped by hidden pits. If the aim is merely to hunt the wild elephant for the sake of his ivory, or flesh and hide, or to get rid of him, or for exalted "sport," the musket or the spike boldly driven into his feet, a large spring-trap driving a stout spike into its body, or other equally simple methods are adopted. Nor is the process so dangerous as might appear. Drummond informs us that the risk is much greater in hunting the lion or buffalo. The elephant soon abandons the pursuit, even though his enemy be clearly in view; it is easy to hide from him in the jungle; and he does not like to run up a hill. It is chiefly the females (even when devoid of tusks) that prove dangerous.

In a state of domestication the elephants are more ornamental than useful. They are somewhat delicate, and though very powerful, are easily injured and disabled by rough work, and often become footsore. It is mainly on occasions of state, as for the royal sport of tiger-hunting, that they are employed. Though usually gentle, yet one will sometimes prove refractory and dangerous, as when one of our American elephant-citizens recently marched at Albany into an iron-foundry, and on experimenting with his proboscis upon the red-hot bars was displeased with the novel sensation. Jumbo, who is one of our latest distinguished immigrants, was celebrated in London for a double personality (if we may so say). Out of doors he was a well-behaved animal, carrying little children on his back, good-naturedly accepting and eating their apples, cakes, and toys; but he was vicious at home, a very tyrant to his keepers, so that their lives were in danger (like human beasts that we have known to be gentle abroad, and savage at home). The elephant's driver ("mahout"), who sits astride on his neck and directs his movements, generally obtains such a command over him as to be able to subdue his fits of passion. An elephant was running madly through an Indian bazaar, when the mahout boldly ran at him, and struck a spear through his proboscis. The pain subdued the monster's fury, so that he desisted from his work of devastation, and permitted the driver to mount and lead him away. Dr. Hooker informs us of an elephant which sunk in an Indian bog, and could not extricate himself till he was assisted by men with ropes. The driver was greatly afraid lest the beast would seize Dr. Hooker himself, and by placing him under its knees as a support (which it is apt to do with any object in reach) would crush him to death. But the keeper had no fear on his own behalf, as the elephant would not take such a liberty with its master.

The recent appearance of two baby elephants, the America and the Bridgeport, in our own country, are cases not merely of popular, but of true scientific interest. The first of these, born in Philadelphia in March, 1880, weighed two hundred and thirteen and one-half pounds. Its mother weighed seven thousand and twenty pounds, and was twenty-three years old; the father weighed four tons, and was twenty-six years old. The period of gestation was five hundred and ninety-three days (over one and a half years). The baby's height at the shoulder was thirty-four and one-half inches; its proboscis was twelve inches long, and nine inches in circumference at the root. It

suckled by its mouth, holding the trunk in the air with an S-like curve. It was from the outset very inquisitive, jealously scrutinizing its mother's food, and testing the quality of visitors' clothing whenever it had the opportunity. Dr. Chapman found out at its birth that the important subject of elephantine placentation had been wrongly laid down in our books. The placenta of the elephant has been stated to be deciduate, in this respect differing from that of ungulates. But it was now found to be non-deciduate and diffuse. As the mode of placentation has in recent years been an important factor in determining the affinities of the mammalian group, and the true mode of classification, this discovery is of scientific value. The rarity of such an event of elephantine life in domestication easily accounts for the previous error.

Though apparently very clumsy animals, elephants are really nimble, moving noiselessly through dense woods, wading through deep waters, and going along at an easy trot that will try a horse to keep up with them. Though their limbs are not elongated like those of a horse or the deer, but on the contrary the heel reaches the ground, so as to be plantigrade, and they seem scarcely to possess any knees, so that they were once believed to have jointless limbs, yet the muscles which raise and control the limbs are large and powerful. The muscles of the fore-limbs, affixed to the broad hatchet-like scapula, with its deep spine and anchor-like metaacromial processes, and those of the hind-limbs to the laterally-expanded pelvis, easily lift up the limbs and swing them forward like pendulums, so as to propel the huge carcass with facility and steadiness.

Of the foot itself, both of fore and hind extremities, Miall and Greenwood say "that the separate mobility of the parts is greater than would be expected from an external inspection, and much greater than in most ungulates. The palmar and plantar soles, though thick and tough, are not rigid boxes like hoofs, but may be made to bend even by human fingers. The large development of muscles acting upon the carpus and tarsus, and the separate existence of flexors and extensors of individual digits is further proof that the elephant's foot is far from being a solid, unalterable mass. There are tendinous or ligamentous attachments which restrain the independent action of some of these muscles; but anatomical examination would lead us to suppose that the living animal would, at all events, accurately direct any part of the circumference of the foot by itself to the ground."

A glance at an elephant's skeleton will suggest, by the long spines above the back and neck, and by the elevated crown of the skull, with its deep cavity behind, how large must be the nuchal ligament, and the many muscles that suspend the huge head to the front of the body, and which afford an easy resting-place for the mahout upon the neck. The body is rather short to belong to such a monster; its twenty-three vertebræ (as many as twenty of them bearing ribs) being condensed together into a stout, short axis with a slight curve. The neck is exceedingly short, its seven vertebræ appressed to each other like a rouleau of thin coins, as if it were designed to bring the head as close as possible to the shoulders, and to save leverage. This system of abbreviation is further carried out in the head, the heavy bones of which are all carried backward as close as possible to the neck. Thus the cheek-bones (malaris) are not on the cheeks at all, but are small, and carried backward to form the keystone of the zygomatic arch behind the eyes. The nasal bones are very small, and their cartilages form valves within the proboscis; the upper and lower jawbones form sockets for the big grinder-teeth which are strung underneath the main part of the skull; and the lower jawbones meet in front in such a way as to form a remarkable spout instead of a lower lip. In this spout the long conical tongue lies, and much of the work belonging

to lips and jaws and cheeks in other animals, is here discharged by the proboscis. This structure of skull is in striking contrast to what obtains in the horse, where jaws, cheek-bones, and nasals are thrown as far forward as possible, so that the incisors may reach the ground and nip the grass.

The prominent parts in the front of the elephant's skull depend chiefly on a two-fold arrangement; namely, the spongy character of the bones, and the enlarged sockets for insertion of the tusks. It has thick spongy bones, having little weight, but bulging at the forehead, so as to produce a false appearance of intellectual power. In a young elephant the bones are not spongy, and the brain nearly fills the upper region of the skull. But as the animal advances in life the bones of the face swell up like a loaf in an oven,

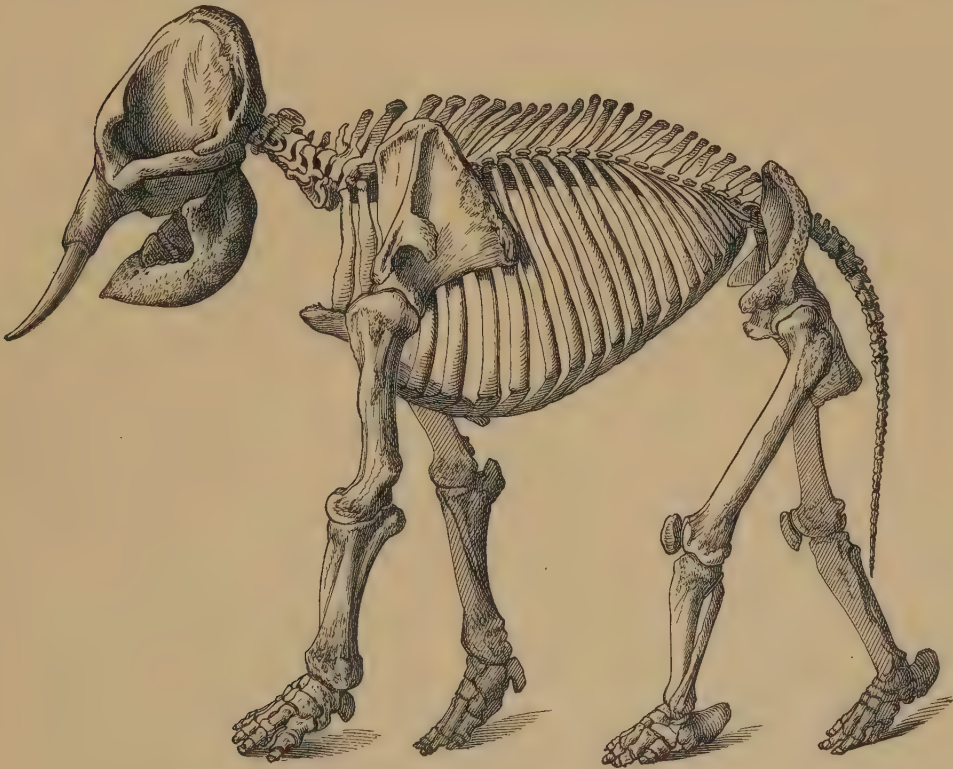


FIG. 115. — Skeleton of the Indian elephant.

the air-cavities of the different bones run into each other, and the brain becomes relegated to a small cavity near the base. The cancellous bone of the face has many radiating lamellæ extending from the internal to the outer surface; the air-chambers of maxillæ, premaxillæ, vomer, and other bones communicate, and the sutures between these bones are obliterated. Sometimes the spongy bone is twelve inches in thickness from its inner to its outer walls. Hence the head is not nearly as heavy as it seems; and this arrangement protects the brain from injury by knocking against the trunks and arms of forest-trees; and, furthermore, it is difficult for a musket-ball to penetrate the mass of spongy diploë so as to reach a vital part. An extra growth of this spongy bone gives the African elephant its prominent forehead; and Drummond ascribes to this its greater invulnerability, as compared with the Asiatic species. "In India and Ceylon

the elephant's forehead presents a certain mark for the hunter's ball, while in Africa it is quite impervious. I have fired, without making the slightest impression, point-blank from ten yards' distance, with a gun of six bore, at the exact spot that in the Asiatic species would be instantly fatal, and the experiment has been as fruitlessly tried dozens of times within my knowledge." It is further manifest, phrenology notwithstanding, that neither the extra bump of the African species, nor the large heads of any of the species, indicate excessive brain-power; though it must be conceded that many nations believe that such big beasts must be tenanted by great souls.

The face of the elephant, or at least its premaxillary bones, are further enlarged in order to support the huge tusks. These tusks are of the nature of incisor teeth (which is shown by the place of their insertion), and in this respect, and by reason of the perpetual pulp from which they grow, correspond with the chisel incisors of the beaver, and of some marsupials (as the wombat). The upper ones not being antagonized by inferior opposing ones, instead of being worn to a sharp edge, end in a conical point, and continue to grow outward. Some of the tusks of the extinct mammoth have been found to curve round into a circle, but the curve being oblique they thus clear the head, and point outward, backward, and downward.

Carse, in India, first made careful observations a century ago on the teeth and bones of Indian elephants, and published them in the *Philosophical Transactions* (1799). He watched the fall and renewal of the teeth, and secured a large number of skulls of different ages. He showed that the elephants have "milk" or deciduous tusks as well as permanent ones, that the milk tusks appear at about six months of age, that they are small and very caducous, falling out between the first and second year. He found in the young skull the place of the capsule of the permanent tusks, which appear a couple of months after the loss of the milk-tusks, and he then observed that they go on increasing during life, for a century or more.

Livingstone saw an African elephant with three tusks; the third (which was situated between the normal ones) may have been a persisting milk-tusk. The base of the tusks is widely open, and the pulp in which they grow is long and conical. The curve assumed by the tusks is such as to distribute the pressure laterally on the bones of the skull, and not against the pulp. Though frequently small they may grow to be five or six feet long, and to weigh nearly two hundred pounds; they become obliquely worn at the tips from being used to root up vegetation, the oblique direction of the wearing showing that they work sidewise rather than forward. At the root of the tusk (where it is buried in the premaxillary socket) the ivory is a thin wall, surrounding the pulp which fills its cavity. More distally it becomes a solid mass of ivory, retaining in its axis a fine line of pith. Foreign bodies, sometimes musket-balls, have been found imbedded in the solid ivory. These had first entered by the root of the tusk, through its thin wall to the pulp-cavity; and they were subsequently transported forward by the continued growth of the tusk, and the solidification of its interior.

The vascularity of the solid part of the tusk is slight. It consists of fine dentine, built up of minute tubules of less than one fifteen-thousandth of an inch in diameter, far too fine for blood-corpuscles to enter. The tubules bend strongly in their course, and their curves, by refracting the light when seen in polished ivory, impart the well-known characteristic decussating striæ. Old tusks that have been long exposed to the weather decompose, not along the lines of growth but in concentric laminae which come off at the places where the interspaces between the tubules is weakest. There is no enamel on the tusks; in this they are unlike the incisors of rodents. The ivory

of the African species is more valuable than that of the Indian species, and hence the former is most briskly sought after for the market. The discovery of such substitutes as vegetable ivory (the seed-food of *Phytelphas*) and celluloid (prepared from gun-cotton) has in some measure relieved the trade in ivory, but about one hundred thousand animals are annually sacrificed for the sake of their tusks, and we may expect ere many years to learn that the African supply is exhausted. F. D. Blyth says that about five hundred and fifty tons of ivory are annually imported to England, involving the destruction of forty-four thousand elephants, besides enormous quantities to America, India, and China; most of it comes from Africa. It costs about £60 per ton. Single tusks weigh from one to one hundred and sixty-five pounds, the average weight being twenty-eight pounds. The largest tusks are yielded by African elephants, and find their exit by the port of Zanzibar; they are noted for being opaque, "mellow" or soft to work, and free from cracks or defects. Those from India, Ceylon, etc., are smaller, opaque (partly translucent), and harder and more cracked. Those from Siam are very "bright," soft, and fine-grained, and are sought after for carvings and ornamental work. The soft ivory which comes from West Africa south of the equator is more highly valued than any other, and is called "silver-gray;" it retains its whiteness when exposed to the air, and does not become yellow like Asiatic and East African ivory. Hard tusks are usually small, and become cracked, and are consequently low-priced. In addition to the above a few tons of mammoth-ivory occasionally come from the Arctic regions and Siberia, and some of these tusks are equal in every respect to ivory obtained from recent elephants.

The total absence of canine teeth from the order of proboscideans is doubtless an example of compensation, as the excessive development of one part is usually attended by the reduction or suppression of the adjoining parts. For the same reason we should scarcely expect to find tusks and horns concurring, though some authors have ascribed both to fossil animals.

No rudimentary or embryonic stages of canines or of lower incisors have been discovered in young elephants. From the shape of the symphysis of the lower jaw, and its resemblance to that of some animals that possess inferior tusks, there is a possibility of the incipient stage of such organs being yet discovered in the embryo.

The molar teeth reach the maximum of massiveness and complexity in these animals, and have many peculiarities which render them fine illustrations of animal mechanics. One or two molars are usually found in each half jaw, sunk in a groove. They are solid blocks, and when the front one which has been in active service wears out, it drops from its socket: thereupon a hind one slips along the groove to the front, and a new one is formed posteriorly to replace it. During the advance forward a considerable resorption and new formation of the bone of the jaws takes place. As the new molar replaces the older ones not vertically but by a horizontal advance, it is not easy to tell where we have premolar teeth (elsewhere known by the displacement of a milk-tooth by its successor), and where we have true molars (where no such succession ever occurs). It is found, however, that the total number of teeth that may appear during life in each half-jaw is six; and Owen believes that three of these are premolars.

The grooves in which the molars move down are curved, like an arc of a circle, concave upward and forward. Thus the growing tooth in its socket is nearly at right angles to the external position. The molars of the upper jaw surpass the lower ones in breadth; and their grinding face is convex antero-posteriorly, while that of the

lower molars is concave. The upper millstone is convex, and so fits the hollow of its nether mate.

Each molar consists of a succession of transverse plates of dentine, faced on every side with enamel, and the interspaces filled with cement, as if the cement had been poured in, or rather had grown up, to fill the cavities, after the plan of forming concrete. Three degrees of hardness result, the enamel being hardest, and projecting most on the face of the tooth; the cement being worn down into valleys, whilst the dentine is intermediate. One of the larger teeth, having sixteen transverse plates, the axis of each plate being the summit of a wedge of dentine, bounded on both sides by projecting ledges of enamel, gives a tritulating face of sixteen wedges of ivory, thirty-two of enamel, and sixteen of cement, or about sixty-four inequalities. The transverse ridges are furthermore somewhat wavy, so that the corresponding surface of the upper and lower molars shall not have their inequalities coalescing. This undulation causes in the Indian species a number of fine zigzags running transversely along the face of the tooth. The African species has fewer ridges, and these so disposed as to present coarse lozenge-shaped figures. The mammoth was an advance on the pattern of the Indian species, having very many fine transverse lamellæ only slightly "crimped."

The first molars of the Indian elephant are in use when he is three months old, and are shed when he is two years old. These have four transverse plates. The second molars have eight or nine plates, and are found in a closed cavity behind the first molar. The third molars have eleven to thirteen plates, are four inches long by two broad; have each a small anterior and a large posterior root, appear above the gum at two years, are in full use at five years, and are worn out and shed by the ninth year. All these are supposed to be milk-teeth.

The fourth molar of each jaw has fifteen or sixteen plates, is seven to eight inches long by three broad, and protrudes at the sixth year (while the third is still in use). It is in full use by the fifteenth year, and is shed some time before the twenty-fifth year. This is the first true molar. The fifth has from seventeen to twenty plates, is nine or ten inches long, by three and one-half broad, and appears at twenty years. The sixth or last molar has twenty-two to twenty-seven plates, and is twelve to fifteen inches long. Thus the later teeth surpass the younger ones in size and complexity, though they may slightly vary in different individuals. The time of life at which the last ones are worn out varies according to the kind of food, and to individual peculiarities. The sixth one is expected to last till the close of life, which may considerably exceed a century.

Professor Owen calls attention to the fitness of the elephant's grinding teeth for its special habits of life. There are few organs which manifest a more striking adaptation of complex structure to peculiar conditions. We perceive, for example, that the jaw is not encumbered with the whole weight of the massive teeth at once, but that they are formed in instalments as required. The front part of each tooth, being most abraded, is fitted for the preliminary crushing of the branches of a tree. The transverse enamel-ridges of the succeeding parts of the face of the tooth divide the branches into smaller fragments; and the posterior part of the tooth is occupied by islands and tubercles (known as "talons") of projecting dentine and enamel, so as to grind the vegetation into a pulp. This plan not only gives the millstone its indispensable unevenness of surface, but secures the chief efficiency for the finer comminution of food, at the part of the mouth which is nearest to the fauces. As evidence of the soundness

of these views we have the fact that in captivity the teeth of elephants usually get out of order, because the soft food supplied them fails to triturate the faces of the molars, which become quite smooth, a pair of molars often coalescing into one mass. The rough shoots and grasses of their native jungles is most efficient in maintaining their proper condition.

Virgil, in the Second Book of the *Æneid*, reports a tradition that Sicily was at one time a part of the mainland, and that the sea bursting in turned it into an island. Whether this was a genuine tradition, or a mere legend, or only a poetical speculation, the remains of fossil elephants set their imprimatur on it, and elevate it to the rank of a scientific theory. Not only was Sicily, but the island of Malta, and even Africa, was united to Italy by a neck of land which held together the two continents of Europe and Africa. In Malta have been found the remains of two species of elephant, in large numbers. These were pigmy elephants (*Elephas melittensis* and *E. falconeri*) about the size of a sheep. Similar remains occur in Italy along with other species, which are found fossil over many parts of Europe. These facts go along with other arguments to validate the theory of an ancient bridge of land from Italy to North Africa, of which bridge Sicily and Malta with its adjoining islets, are fragments.

The remains of other species of elephants have been found in different parts of Europe and Asia, many of them in the bed of the German Ocean east of England (relics of the time before England was divorced from continental Europe, and when it was covered with subtropical vegetation), many others in the Sivâlik hills of India, and the mammoths extending over Central and Northern Europe and Asia. These remains are so abundant that Siberia and the German Ocean have become hunting-grounds or fishing-grounds for ivory; and Siberian ivory has been extensively used for making dice, statuettes, and other trinkets. In America remains of the mammoth have been found in Alaska, and as far southward as Oregon, and in the Southern States the teeth of a species (*Elephas columbi*) closely resembling the Indian elephant. It is curious that while the teeth of these animals have been frequently found in our country, their bones are very rare. They have been so long extinct in the New World, and their huge bones are so easily disintegrated that all except the hardest portions have disappeared.

In the New World are found the bones of closely-allied forms. The Red Indians called them the remains of the "Fathers of Oxen," said that they lived in old times along with gigantic men, and that the Great Spirit destroyed them all with his thunderbolts. Dr. Barton states that in 1761 there were found, by the Indians in America, five carcasses, with long noses above their mouths. There is reason to believe that these animals lived quite recently in the United States. One of the animals whose remains first attracted notice in our country was called the "Ohio beast." Though not an elephant, it had much of the family likeness, short neck, large skull, with sponge-like bony plates, a place for a proboscis, tusks in the upper jaw, large complex molar teeth, expanded pelvis, and pillar-like limbs, with elephantine wrists and ankles and toes. It differed from the elephant chiefly in the form of the molars, which had a series of pairs of large conical projections, instead of flat grinding surfaces; being less worn, and adapted for softer food. From the resemblance of these projections to nipples, the animals have been called Mastodons. Besides the "Ohio beast" (*Mastodon americanus*), remains of other species have been found in North and South America (*M. mirificus* in the Loup Fork of Nebraska, *M. Humboldtii*, and other

species in the Chilian Andes and La Plata, and *M. productus* from Nebraska, remarkable for having two large *lower* tusks). Several species of mastodon have been found in the old world, some of them in India, and *M. angustidens* in Europe. Some of the species show the transitions between the elephantine and the mastodontic types of teeth, so that by putting them together we have a series of twenty-five or thirty species, many of them the largest land animals that ever existed on the earth, and blending together by regular gradations of structure.

Remains of a third group have been found in the old world, but they are as yet unknown in America. These belong to the *Dinotherium*, first described by Kaup from a piece of a skull found on the Rhine, and afterwards found in India, and in the Isle of Perim, at the entrance of the Red Sea. Only the skull and a few of the leg-

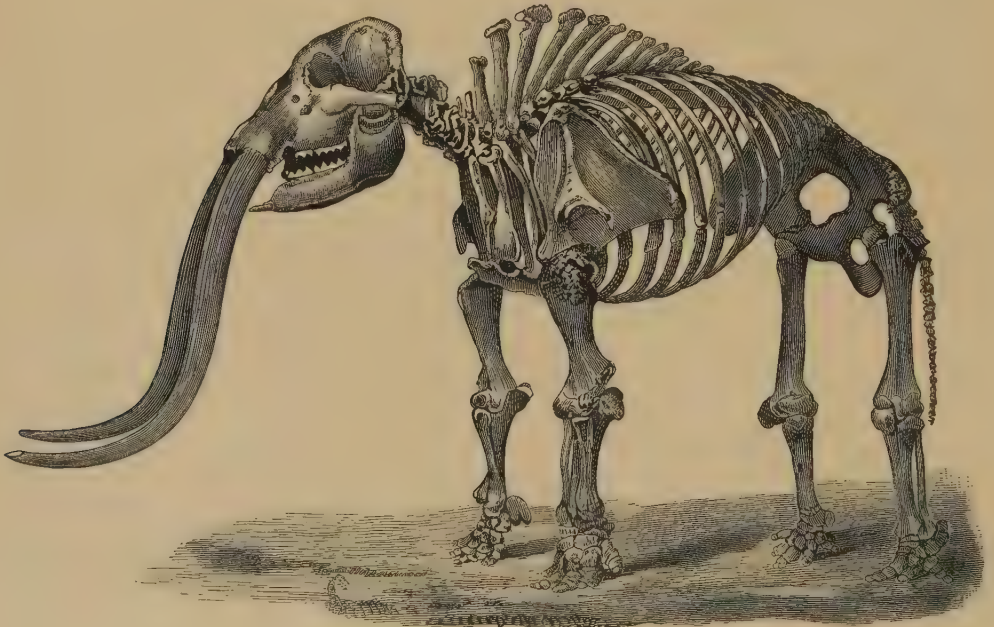


FIG. 116. — Skeleton of *Mastodon americanus*.

bones of this genus have been found. It had the chin bent down so as to support two large tusks projecting downwards from its lower jaw, as if for tearing up weeds, or for anchoring itself along the banks of streams. Its molar teeth were somewhat after the elephantine type, but much simpler in structure, and not increasing in complexity backwards.

In *Mastodon* the intermediate molars (including the last premolar and the first one or two molars) have usually three ridges in one series of the species (hence called the Trilophodon group), and four ridges in another series (the Tetralophodon group). The front premolars have fewer, and the hind molars have more, ridges than the intermediate formula, the common difference being one; whilst the intermediate teeth do not differ among themselves. Some of the forms have five as the intermediate ridge formula (the Pentalophodon group). These ridges in the mastodons support each of them a pair of nipple-shaped prominences, the intermediate valleys not being filled

with cement. Owen believes that both sexes of the mastodons had, in addition to the upper tusks, a pair of lower tusks projecting forward, but that these disappeared in the female when young, and only the right one was retained by the male. Some of the American fossils have small inferior tusks, and *M. productus* has both of them rather large, but one of them longer than the other.

The elephants differ from the mastodons by having higher intermediate formulæ (varying from six upwards), and by having the valleys more or less filled up, and the nipple-like projections obsolete. In one group (*Stegodon*) the ridges are even more prominent than in *Mastodon*, and the common difference between the ridges of adjoining teeth is one. Members of this group occur as fossils in India. They approach the mastodons, but have a ridge formula of seven or eight, and much cement filling the valleys, the ridges convex with many points to each ridge. *Loxodon* includes the African elephant, the pigmy elephants of Malta, and several Indian fossil forms. It has two as the common difference. *Euelephas*, which includes the Indian elephant of our day, and the mammoth, and the fossil *E. columbi* of America, has an intermediate ridge-formula of twelve or fourteen and a common difference of about four. The premolars of the Indian elephant are $\frac{4}{1}-\frac{8}{3}-\frac{24}{4}$, the permanent molars $\frac{14}{1}-\frac{18}{3}-\frac{24}{4}$ to $\frac{27}{7}$, or often $\frac{12}{2}-\frac{16}{3}-\frac{24}{4}$ to $\frac{27}{7}$. Behind the ridges, especially in the hind molars, outlying elevations or "talons" occur, which Falconer does not include in these formulas.

Falconer compares the molars of the whole order, dividing the species according to the several types of teeth. First came *Dinotherium*, which at a certain period of life had two middle molars with a ternary ridge-formula. These were the last milk-molar and the first true molar, which for a time co-existed, were contiguous, and were both characterized by having their crowns divided into three transverse ridges. All the other molars and the premolars had a binary ridge-formula; the complete formula being, milk-molars 2 + 3, premolars 2 + 2, molars 3 + 2 + 2. The adjoining milk-molar and molar, Falconer terms the "intermediate molars;" these are simpler in *Dinotherium* than in any others of the order, yet they surpass in complexity all other mammals. The closest approach to them is found in the tapirs, and Cuvier thought *Dinotherium* was a gigantic tapir. The tapirs, though unlike proboscideans as to incisors and canines, approach them in having premolars with semi-cones and ridges, and molars with wedge-shaped eminences, but not enlarging posteriorly. The posterior molars of *Dinotherium*, though not so complex as in other proboscideans, have the out-lying eminences or "talons" that are characteristic of the order.

The geographical distribution of the Proboscideans is best understood by a reference to their past history. They are now discontinuous, confined to India and its neighborhood and Central Africa, whilst the semi-fossil mammoth was in Northern Asia. But they were at one time distributed over all the great continents. They seem never to have reached Australia. None of the group have existed in islands unless these islands were at one time joined to the continent. Their remains occur only in fresh-water deposits, as the Sivâlik Hills of India, and the later beds of Nebraska and Texas. Even the bed of the German Ocean seems to be of fresh-water origin. They first appeared in the Old World toward the close of the miocene or in the early pliocene age, the age of forests over all continents, when Europe had dense jungles, and semi-tropical vegetation like that of our southern states. From the old world they possibly migrated (in common with many other large animals) to North America, and thence to South America; and a different group (the Loxodons) from Asia to the eastward parts of

Africa, and thence, by the Maltese and Italian highway, northward. The mastodons began somewhat earlier, and probably remained longer in the new world than the elephants, having perhaps found a refuge in marshy regions after the elephants had been exterminated from the forests by big carnivores.

Whence these giant beasts came we cannot tell. We shall see that the tapirs belonging to the perissodactyle ungulates show in their molar teeth an approximation to the proboscideans. Also the *Hyrax*, or rock-rabbits of Syria and South and West Africa, have many points of structural agreement with the elephants (as large premaxillaries, the malar bones thrown back into the zygomatic arch, and the structure of the feet, and even the molar teeth), though in size and habits and many structural details they widely differ. All these groups agree in being discontinuous; they are scattered fragments left in a few localities to represent orders of animals that were once wide-spread over the world, — the tapirs being now found in South America as well as the East Indies. Professor Cope thinks that they may all have branched from some primitive stock of eocene times. At one time he would have placed the Amblypoda (illustrated by the wide-spread *Coryphodon* found in the old and new world eocenes) as the original group, but now he goes still further back to the group which he calls Taxeopoda. *Coryphodon* was as large as an ox, and had the wide elephantine pelvis; but it had canine tusks, and the bones of proximal and distal rows of the carpals alternated with each other, while those of the Proboscidea and *Hyrax* are in the same longitudinal lines. All the members of the proboscidean order were well differentiated at the close of the miocene age, and have scarcely changed since. Falconer justly suggests that it is difficult to evolve them out of any known eocene forms.

In this group we have an example of what A. R. Wallace notes as a course of depopulation of the continents so far as big beasts are concerned. The advent of tigers, and of man, the most predaceous of animals, and the deforesting of many regions, along with alterations of climate, have secured their extermination. Even the African elephants are now exterminated from the southern colonies of their continent, and the Asiatic species is protected only for the purpose of being enslaved to dominant man. But the search for ivory in the one country, and the advent of steam-machinery to the other, promise soon to end their career. The slow increase of the race, the smallness of their families, and their great size, all combine to secure their annihilation. They were at one time the lords of the herbivora, continuous, and even dominant over both worlds. Now they have only a few survivors in the combat of life, and these driven to inaccessible lurking-places by that more dominant primate, who annihilates every beast which he does not deign to enslave.

G. MACLOSKIE.

ORDER VIII.—HYRACOIDEA.

The small animals for which Professor Huxley framed this order have made nearly as much trouble for biblical scholars as for students of natural history. There are several places in the Bible where the word "shaphan" occurs, and these our translators have rendered by "coney," under the impression that the rabbit was meant. These passages are as follows: Leviticus xi. 5: "And the coney, because he cheweth



FIG. 117. — *Hyrax syriacus*, coney, daman.

the cud, but divideth not the hoof; he is unclean to you." Deuteronomy xiv. 7, repeats the same idea. Psalms civ. 18: "The high hills are a refuge for the wild goats, and the rocks for the conies;" and Proverbs xxx. 24-28: "There be four things which are little upon earth, but they are exceeding wise; the ants are a people not strong, yet they prepare their meat in the summer; the conies are but a feeble folk, yet they make their houses in the rocks; the locusts have no king, yet they go forth all of them by bands; the spider taketh hold with her hands, and is in king's palaces." These descriptions, meagre as they are, are still sufficient to enable us to recognize that the *Hyrax*, or daman, was intended, the only fault being that the *Hyrax* does not really chew the cud, but when sitting quietly it keeps its jaws in such constant motion that one would readily mistake it for a rumination similar to that so familiar in sheep

and cows. The *Hyrax* lives in holes in the rocks, and is said to be extremely wary and timid, thus justifying Solomon's remarks about its wisdom.

The zoologist's difficulty has been to assign these animals to their proper place in the systems of classification. First placed among the rodents, they were then transferred to the pachyderm ungulates near the elephants, and lastly assigned, by Professor Huxley, to an ordinal position next to the Ungulata.

The Order Hyracoidea is characterized by two curved incisors, with persistent pulps, like those of rodents, in the upper jaw, and four cutting teeth in the lower. The palmar surfaces of the feet are furnished with pads like those of the rodents and carnivores, the fore-feet having four, and the hind-feet three toes, with the terminal joints enclosed in hoofs. These hoofs are straight and flat with the exception of that of the inner hind toe, which is curved. The tail is very short, a mere tubercle. The body is covered with a short hair, among which occur scattered hairs of greater length. On the face the hairs become much stouter, taking the form of bristles around the nostrils and above the eyes.

The single genus, *Hyrax*, with a dental formula, $i \frac{1}{2}$, $c \frac{3}{8}$, $m \frac{8}{7}$ or $\frac{7}{7}$, has been divided by Dr. Gray into three sub-genera, with ten species, but the validity of some of them is extremely doubtful. The best known forms are the Coney or Daman, *H. syriacus*, and the Klipdachs of the Boers, *H. capensis*. The coney is a small animal about the size of a rabbit, or a little larger, and is covered with a rather coarse brownish fur. Like its southern relative it lives in holes among the rocks of mountainous districts, and while feeding it is said that they post individuals as sentinels, who give warning of the approach of danger by a shrill cry. It chiefly prefers the young shoots of shrubs, but will eat grass, herbs, and flowers, and is very fond of salt. The coney can be easily tamed, but does not make a very interesting pet. In its distribution it extends from Syria south to Abyssinia, and the head of the Red Sea. The *Hyrax capensis* has much the same habits, and is found in the mountainous regions near the Cape of Good Hope. A third species, *H. arboreus*, is found in South Africa, extending as far north as Mozambique. This differs from the two species already mentioned by longer hair, and by a white spot on the back. Still another form, *H. sylvestris*, from the Guinea coast of West Africa, is said to vary in its habits, living in hollow trees. No remains of the Hyracoidea are known before the present geological age.

J. S. KINGSLEY.

ORDER IX.—TOXODONTIA.

This extremely curious group of extinct mammals has been founded upon some fossils from late tertiary (or perhaps quaternary) beds of South America. It contains two genera, *Toxodon* and *Nesodon*, of which the former is the better known.

Toxodon was a large animal about the size of a hippopotamus, and with a massive skeleton which presents very puzzling affinities to the ungulates, rodents, and edentates, as well as some resemblances to the Sirenia. The skull is flattened, and the supra-occipital region slopes obliquely upwards and forwards; the cranial cavity is very small and indicates a low grade of intelligence; the zygomatic arches are long and strong, and bend strongly outwards. The openings of the nasal cavity are directed upwards, as in the Sirenia. The dentition is very peculiar. In the upper jaw are four incisors, the median ones are small, the lateral large, but there are no upper canines. The lower incisors are six in number, and a pair of very small canines is present. The structure of the incisors resembles that in the rodents. The molars, seven above and six below, are convex externally and concave internally, and with flat grinding-surfaces. They are devoid of enamel on the inner side, and are divided by internal valleys into two lobes. These teeth grow from persistent pulps, that is to say they form no roots, but continue their growth during the life of the animal. These molars recall in some particulars those of the edentates, but the presence of canines and incisors would forbid the reference of the genus to that group.

The skeleton of the trunk and limbs is most like that of the Perissodactyla and Proboscidea. The vertebræ of the neck are short, and have plain articular faces; the atlas is strikingly like that of the rhinoceros. The vertebræ of the trunk are very imperfectly known, but the ribs are of a spongy texture internally, like those of land mammals, and not solid as in the Sirenia.

The scapula resembles that of the tapir and rhinoceros, being entirely different in shape from that of the elephant. The limbs were evidently short and massive, the humerus resembling the corresponding bone of the rhinoceros. The forefoot is entirely unknown.

The pelvis is like that of the rhinoceros, while the femur is very like that of the elephant in its proportions and in the absence of the third trochanter, which is characteristic of the Perissodactyla. The tibia is also elephantine in character, and the knee joint was free from the body, as in the elephant, so that the peculiar action of the hind limb in that animal was probably reproduced in *Toxodon*.

The hind foot has lately been described by Professor Cope, who regards it as showing a high grade of specialization of the proboscidian foot. The number of toes was probably five; the heel rested on the ground, and the instep arched strongly upward from it. The calcaneum has a very large facet for the fibula, and the upper surface of the astragalus is nearly flat, showing that the chief motion of the hind limb in walking is at the knee-joint, as in the elephant.

Nesodon is known only from the skull and teeth. Most of the species seem to have been considerably smaller than *Toxodon*. The full number of teeth, namely forty-four, was present in an unbroken series. The incisors were implanted by fangs. The upper molars had very long crowns, but ultimately formed fangs. The outer side was ridged

and the inner penetrated by one or more enamel folds. The lower molars were divided into two lobes, each penetrated on the inner side by an enamel fold. These teeth are not essentially different, except in the extraordinary length of their crowns, from those of the rhinoceros. The skull is not perfectly known, but is generally perissodactyl in character.

In spite of the large number of bones which are now known, the systematic position of the *Toxodontia* is a very puzzling question which at present cannot be positively answered. Professor Cope is inclined to regard them as highly specialized Proboscidea, but our knowledge of them is as yet not complete enough to allow us to classify them with the elephants. They certainly have a close relationship to these animals and also to the Perissodactyla, but for the present it seems best to consider the group as having an ordinal value. *Nesodon* would seem to be the least specialized member of the order, and the one which shows the closest resemblance to the Perissodactyla; but until the predecessors of these animals are found in the middle and early tertiary of South America we must remain in more or less uncertainty with regard to their origin. They belong to the great ungulate division of mammals, and "are probably to be regarded as an aberrant group of the older ungulates." These older ungulates often exhibited a curious combination of characters, as is well shown in many of the eocene forms of North America, and it seems that the *Toxodontia* have retained some of these combined characters while developing a number of peculiar specializations not known in the other allied groups.

W. B. SCOTT.

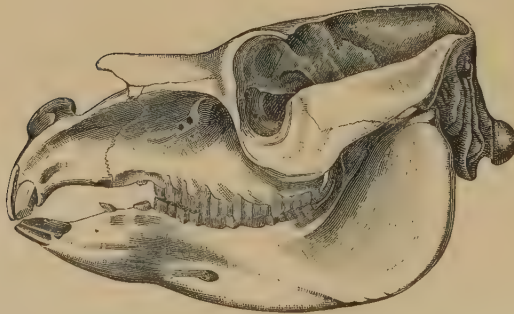


FIG. 117.—Skull of *Toxodon burmeisteri*, one-twentieth natural size.

ORDER X.—UNGULATA.

The term Ungulata (hoofed animals) is employed in a wider and in a narrower sense. We propose to use it here in the latter, the elephants (Proboscidea), which were often associated with the ordinary hoofed animals by the older zoologists, being discussed as representatives of a separate order. Recent discoveries in American palæontology rather suggest the propriety of extending the term so as to include the elephants and the Hyracoidea, but its restriction here will better serve to call attention to the wide gaps which now exist between the living descendants of a common stock.

The "hoof" to which the ungulates owe their name is nothing else than one of the many modifications which the skin undergoes where it is subjected to pressure.

Instead of the horny thickening being confined to the front of the fingers and toes, as in the nails and claws of the other mammals, it forms an almost complete case for the last joint, and replaces functionally the pads on the under surface of the toes in the dogs and cats. Unlike these "digitigrade" animals the ungulates walk on the points of their toes, and it is, in fact, to the circumstance that the ancestors of the living forms used their feet for locomotion alone, and not for prehension, that we must look for the explanation of the foot-structure of the horse and ox and their allies. In this respect the horse and ox may be looked upon as culminating points of two series of forms in which the weight of the body, at one time supported by all the toes, has gradually been transferred to a single toe (the third) in the one case, and two (the third and fourth) in the other. They may be taken as types of the two great divisions of the ungulates, the odd-toed



FIG. 118.—Foot of horse (Perissodactyla).

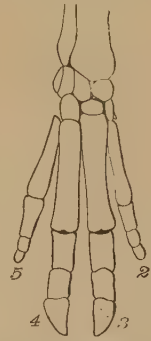


FIG. 119.—Foot of pig (Artiodactyla).

ungulates (Perissodactyla, Imparidigitata), and the even-toed (Artiodactyla, Paridigitata). Any account of the living animals would be incomplete without at least a passing allusion to the fossil animals which have largely been obtained from American tertiary strata, and which have enabled the American palæontologists to trace the history of the evolution of the hoofed animals more completely than that of any other group.

Professor Cope believes that he has discovered, in the five-toed *Coryphodon*, a representative of the ancestral group from which both the odd and even-toed ungulates have sprung. In that genus the middle toe is somewhat larger than the others, and it is easy to understand that in locomotion on dry ground it would be subjected to more pressure, and bear more of the weight of the body than the others. It is further a well-known physiological principle that the more a part is used the better it is supplied with nourishment, and, as the converse also holds good, we have here the key to the gradual lessening in size of the outer toes, and their eventual almost total loss. The fossil horses of America show very plainly the various stages of this reduction in the number of toes, and the rhinoceroses and tapirs (animals by no means so well adapted

for rapid locomotion) are living examples of halfway stages in this respect. The ancestors of the even-toed ungulates, Professor Cope considers, were probably swamp-lovers, like some of their present descendants (the pigs and the hippopotami). To gain a firmer footing in the swampy soil the toes were probably divided into two groups, the first, second, and third toes being separated by a wide cleft from the fourth and fifth. When the possessors of such feet, however, took to drier ground, the same law referred to above came into operation, so that to begin with, the first toe became rudimentary and lost, and then the second and fifth succumbed to a greater or less extent, as we see exemplified in the oxen and deer of the present day. There is no more interesting chapter in comparative anatomy than that which deals with the foot-structure of the ungulates.

In the course of this loss of the side toes in the even-toed ungulates, the central toes either gradually appropriated the support of the small bones of the wrist and ankle joints, which belonged to the side toes, or else the small bones proper to themselves merely became enlarged. The Russian palæontologist, Kowalevsky, has produced abundant evidence that the animals in which the former occurred were best adapted to succeed in the struggle for life, and that the others are now only known by their fossil remains. Thus an advantage, which must have been of very slow development and of infinitesimal value to any particular animal, has nevertheless led to the supremacy of certain forms, and to the extinction of others.

Kowalevsky points out that in the odd-toed ungulates the third toe of necessity gradually occupied the whole of the surface of the wrist and ankle-bones, for it would have been impossible to keep the body in equilibrium on a single toe if this had not been the case. It is obvious that this striving on the part of the middle toe to occupy the whole surface of the joint has been one of the important factors leading to the disappearance of the side toes. We shall see that in the horses, the most highly developed of the odd-toed ungulata, the side toes have entirely disappeared, with the exception of the rudimentary second and fourth metacarpals and metatarsals—the “splint-bones” of veterinary anatomists.

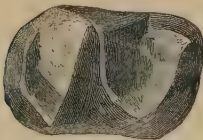


FIG. 120. — Bunodont tooth (*Palæosyops*).

Simultaneously with changes in the bones of the feet, another set of organs has been subjected to gradual alterations of prime importance to palæontologists. We refer to the teeth. There is hardly any doubt that the ancestors of the hoofed animals were omnivorous, and had tubercular teeth like the pig's, while the herbivorous animals represent a later stage of evolution, and have grinding teeth of a crescentic pattern. Both odd-toed and even-toed ungulates diverged along the lines indicated here, some retaining the tubercular (bunodont) others acquiring the crescent-patterned (selenodont) molars. At the present day most of the ungulates are characteristically herbivorous animals, and we accordingly have few remaining which possess the bunodont dentition, while the horse and ox which form the culminating points of the odd and even-toed series respectively, have both reached the most perfect stage of selenodont dentition.

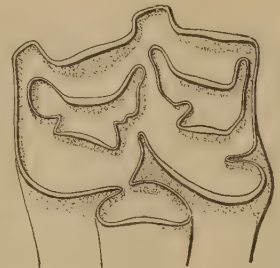


FIG. 121. — Selenodont tooth (*Equus occidentalis*).

In the above paragraphs we have endeavored to sketch shortly the factors which have been at work in giving rise to the very varied series of forms of living

ungulates, which are now, by the common consent of naturalists, arranged under two sub-orders, unconnected by any living intermediate form, the Perissodactyla and Artiodactyla.

SUB-ORDER I.—PERISSODACTYLA.

The Perissodactyla, or odd-toed ungulates (*Imparidigitata*) include only the living horses, rhinoceroses, and tapirs, and the group is consequently much less rich in genera and species than that of the Artiodactyla, which include the numerous cloven-footed animals.

All of these names for this sub-order call attention to the fact that the toes are generally odd in number, that is, either three to each foot or one; but it must be remembered, in view of one or two exceptions to this rule (in case of the fore feet), that the real anatomical characteristic of the foot structure of the group is that the axis of the limbs passes through the third toe (Fig. 122), and not through the interval between the third and the fourth toes, as in the cloven-footed animals. The third toe thus acquires a certain amount of independence, which is first shown by its being symmetrical in itself: gradually it comes to sustain the whole weight of the body, and its last joint is then necessarily much expanded, as we see in the coffin-bone of the horse. Other osteological features of the Perissodactyla are the absence of clavicles, the presence of a third trochanter on the femur, and the great number (from twenty-two to twenty-five) of the trunk vertebræ. The first of these peculiarities is shared by the Artiodactyla, but they are destitute of the third trochanter, and have never more than nineteen trunk vertebræ.



FIG. 122. — Fore foot of tapir.

The living Perissodactyla are animals of large size; the skin is sparsely haired, and sometimes extraordinarily thick; the great length of the skull is due to the elongation of the facial region, for, as in all hoofed animals, the brain is comparatively small, although its surface is convoluted. The skull bears no antlers or horn-cores, the horns of the rhinoceros being purely dermal structures.

The teeth, which are sometimes present in the number which may be regarded as typical for the primitive hoofed-animal, are $i.3$, $c.1$, $pm.4$, $m.3$. Certain of these may be reduced, as we find, for example, in the African rhinoceros, but never in the way peculiar to the ruminants, where the incisors and canines of the upper jaw are entirely absent in the adult. The canine teeth are sometimes absent, but when present are always small, and never form projecting tusks, as is so common in hornless Artiodactyla. The hindmost premolars are as large as the molars, and like them bear ridges of unsymmetrical pattern, the intervals between which are most completely filled up with cement in the horses. In accordance with the herbivorous habits of the animal the intestine is of great length, but the stomach retains the simplicity of form which probably characterized the primitive Ungulata. This is, perhaps, compensated for by the enormous size of the cæcum, which much exceeds in length the same organ in the Artiodactyla. In no Perissodactyla do we meet with the specialized form of placenta which is characteristic of the ruminants; it is always diffuse.

Of ten families of typical Perissodactyla recognized by Professor Cope only three are represented by living species, viz.: the Tapiridæ, Rhinocerotidæ, and Equidæ. Fossil members of these three families do not occur before miocene times, and, indeed, most of them are confined to higher strata, so that the families are of comparatively recent

origin. The most generalized type of perissodactyles is the five-toed, tubercular-toothed *Phenacodon*, described by Cope, from the lowest eocene beds (the Puerco and Wasatch), but this type very early gave place to the Lophiodontidæ and Chalicotheriidæ, which were very abundant throughout the whole of the eocene period, and had the toes already reduced to four on the fore feet and three on the hind, like the tapirs. Their teeth, also, had already begun to lose the tubercular type, and to assume the transversely lobate or lophodont type, which eventually gave rise to the complex crescentic pattern of the horse's molar.

The miocene representatives of the sub-order were chiefly Rhinocerotidæ and Palæotheriidæ, the former beginning to show the reduction in the incisor and canine teeth, which reaches its climax in the living African rhinoceroses, the latter retaining the full complement of these teeth, as do the tapirs and horses. Both of these families had only three toes on the fore feet, of equal length in the rhinoceroses, but undergoing the reduction in the Palæotheriidæ which has culminated in the horse of the present day. In the older forms, like *Palæotherium*, from the upper eocene, the lateral toes were still large, but in forms like *Meshippus* and *Anchitherium*, from the oligocene and middle miocene respectively, these began to be much reduced in dimensions. As we shall see in discussing the fossil horses many of the Palæotheriidæ were direct progenitors of the horses of the present day, and it is very interesting to note that fossil remains of the horse are found in the same strata with those of less fortunate relatives, like the *Protohippus*, which became extinct in virtue of their less perfect foot structure.

The tapirs certainly constitute the most generalized family of living Perissodactyles, for not only do we find the complete dentition and the fourth toe on the fore feet in support of this view, but the skeletons of many of the fossil forms have distinctly "tapiroid" characteristics. We shall therefore describe the members of the family TAPIRIDÆ before taking up the rhinoceroses and horses.

Wallace considers that the geographical distribution of the tapirs points to their approaching extinction, for we find one of the species inhabiting the Malay Peninsula and the neighboring large islands, while the others inhabit Central and South America. From the absence of true tapir remains in American miocene strata, Wallace believes that they are an old world group which only entered the American continent at a comparatively recent epoch. On the whole there appears to have been an increase in size from the earliest ancestral form, for some of the Lophiodontidæ did not exceed a rabbit in size, while the tapirs are considerably larger than a hog.

In the shape of the head and body there is something that recalls the hog, for the trunk is massive and the legs stout and short, but the long prehensile upper lip, the short ears, longer neck, and short thick tail are eminently characteristic of the tapir. The skin is soft, covered with short close hair, which varies in amount and distribution in the different species. The vertebræ of the trunk are twenty-three or twenty-four in number, and of these generally nineteen bear ribs; the tail has twelve joints. The skull is chiefly peculiar in the wide distance between the nasal and premaxillary bones, and the articular end of the lower jaw is of immense strength. The teeth are arranged according to the following formula, $i. \frac{3}{3}, c. \frac{1}{1}, p. \frac{4}{4}, m. \frac{3}{3}$. The outer upper incisors and the lower canines are of large size; the upper canines are small and separated by a short gap from the incisors, but there is a much wider gap (diastema) between the canines and the grinders. These have the simplest pattern of living perissodactyles. The four toes of the fore-feet appear to constitute an exception in

this order of the odd-toed ungulates, but examination speedily shows that the outermost toe does not share in the support of the body, and that the middle one of the other three (the third) is symmetrical in itself, and that which in the horse monopolizes the function of support.

The Old-World Tapir (*Tapirus indicus*) is larger, and especially longer, and somewhat more gracefully built than the American

species. It is immediately distinguishable from these by the broad white mark which extends over the rump to the under surface of the belly, while the rest of the coat is black.

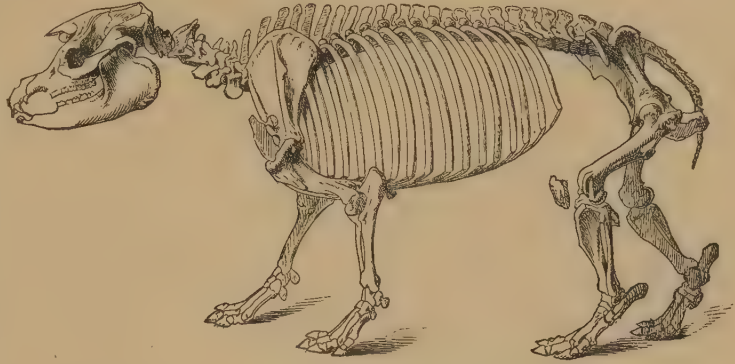


FIG. 123. — Skeleton of tapir.

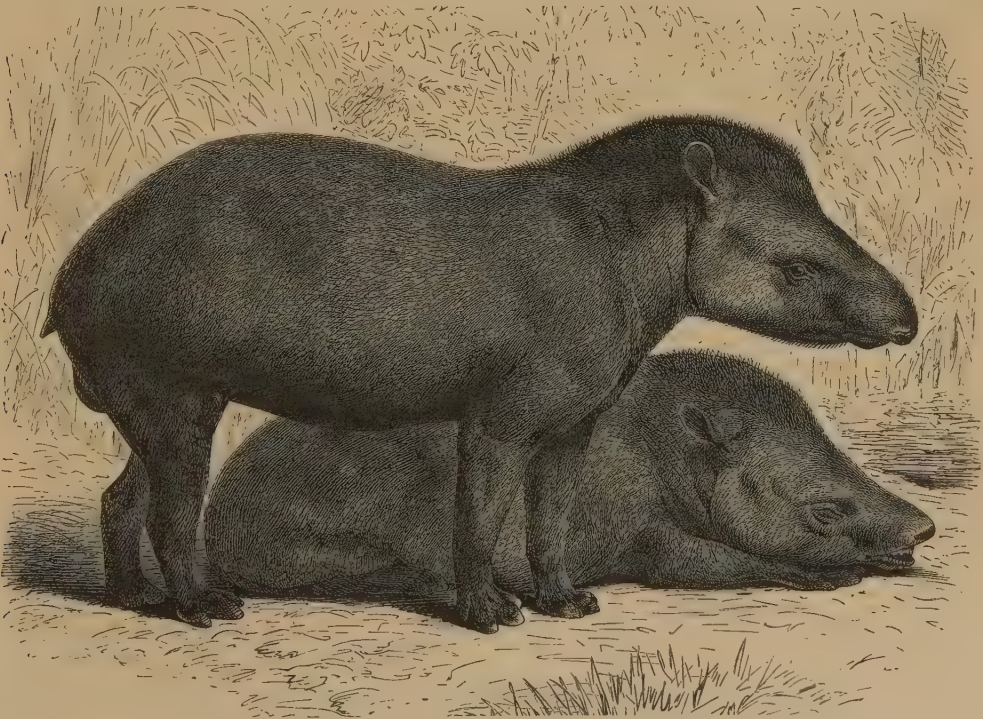


FIG. 124. — *Tapirus americanus*, American tapir, one-sixteenth natural size.

The length is about eight feet, the height at the shoulder thirty-nine inches. The prehensile snout is employed for securing young leaves and twigs, the chief food of this as well as the new-world forms. The habits of the Indian species, which ranges from Borneo and Sumatra to Malacca, are but little known, but probably very similar to those of its American allies. Better known than the above is the common South American species

T. americanus. These tapirs are found in all thickly-wooded districts of South America as far as the foot of the Andes. They have been subjected to a good deal of persecution for the sake of their hide and flesh, both of which are valued, and accordingly are very shy and wary in the neighborhood of settlements. Living on all sorts of young leaves, shoots, and fruits, they are regarded as somewhat dangerous neighbors to plantations, and may often do a great deal of damage in a single night. In their habits they are crepuscular or nocturnal, and are further fitted, by the thickness of the skin, for penetration of the thickest underbrush, so that the pursuit of them is attended with con-



FIG. 125. —*Tapirus indicus*, Indian tapir, one-eighteenth natural size.

siderable difficulty. Of all the Perissodactyla this is probably the most swamp-loving species. They are said to swim well, and take to the water readily, when they are most easily secured. Dogs are employed to drive them from the thickets into open country. The male tapirs are somewhat solitary in their habits, associating with the females only at pairing time. Only one young is dropped at a birth, after a period of gestation of four months. The young is spotted and striped, as is the case with the other species, and in this respect present a singular contrast to the adult which, especially in this species is of a very uniform color. The coat of the adult is of very short grayish-black hairs, which are somewhat paler at the sides of the neck, and from their greater length on the middle line of the head and neck form a short, stiff mane. In

size the female somewhat exceeds the male, and may attain a length of almost seven feet.

A second South American species from the Andes occurs under very different circumstances from the above-mentioned form. It is always found at high levels on the Corderillas, ascending to between seven and eight thousand feet. The skin is uniformly covered with hairs an inch in length and mostly brownish black, whence it is spoken of as the Hairy Tapir, and is known to naturalists as *T. roulini* from its first describer, M. Roulin. The hairs on the nape and sides are a little longer. There is a white spot at the corners of the mouth which may extend on to the cheeks; the end of the snout and the edging of the ears are also white, while the sides are of a bluish hazel instead of brown. In length the hairy tapir measures fifty-four inches, and stands twenty-six inches high at the shoulder.

Two species of tapir have been recently discovered in Central America which present so many important points of difference from the South American species that Dr. Gill established the separate genus *Elasmognathus* for them. They rather approach the Indian species in the structure of the skull, but are characterized by the ossified nasal septum. *E. bairdii* from Nicaragua is forty-two inches long and twenty-three high. It is brownish black on the upper parts, but the face is rufous and the throat and chest dirty white. Professor Verrill has described the young of this species as of reddish brown color with ten longitudinal rows of white patches on the sides blending into stripes. The sides of the face and the legs are also striped. *E. dowi*, the second species, is found both on the Pacific and Atlantic slopes of Central America, being recorded from Guatemala and the east coast of Costa Rica. This species wants the rufous cheeks of the latter form. Little is known of the habits of these Central American species, but Dr. Gill suggests that the great difference in the structure of the skull is probably associated with some difference of habit.

The living members of the family RHINOCERIDÆ have only three toes on each foot, the second, third, and fourth, and these are equally long, but the weight of the body does not rest upon the small hoofs which cover the terminal joints, but rather upon a hard, rough pad which is formed on the under surface of the toes higher up. The third toe alone is symmetrical in itself, its last joint being somewhat similar to the coffin bone of the horse. The skin is excessively thick, a circumstance which induced the older zoologists to associate the rhinoceroses with the elephants and hippopotami as "Pachydermata." It may be converted into a series of impenetrable shields, the surfaces of which are marked off into tubercles between which the scanty hairs spring. The head is elongated like the tapirs, but proportionately broader. The leaf-eating species have a prehensile upper lip, but it is never prolonged into a rounded proboscis. The middle line of the nose bears one or two horns, destitute of a bony core, and composed of agglutinated fibres which are developed in the same way as hairs. No canine teeth are present even in the milk set; the incisors are $\frac{3}{2}$ in the milk set, but disappear partly or entirely in the permanent set; the molars are 7, and their surface has a pattern intermediate in complexity between that in the tapir and the horse. The tail has twenty-two vertebræ instead of twelve.

The living species of rhinoceros, six in number, are equally divided among three sub-genera, *Atelodus*, *Ceratorhinus*, and *Rhinoceros*. The first of these is confined to Africa; the second and third extend from the larger islands of the Malay Archipelago up the Malay peninsula to British Burmah, Assam, Bengal, and as far north as the foot

of the Himalayas. The genera are readily distinguished by the nature of the skin, which in the African forms, *Atelodus*, does not shape itself into the distinct shields so characteristic of the Indian one-horned rhinoceros (*Rhinoceros* proper), while the genus *Ceratorhinus* is intermediate between the others in this respect. Again, the two former genera have two median horns, while the latter has only one. The African species are destitute of incisor and canine teeth, while these are arranged according to the formula *i.* $\frac{1}{1}$, *c.* $\frac{0}{0}$, in the Indian species.



FIG. 126. — *Atelodus bicornis*, two-horned rhinoceros.

A somewhat detailed account of the habits and mode of life of the African rhinoceroses will enable us to dispense with any long descriptions of the Indian species, which in fact are much less known both to sportsmen and naturalists.

After a residence of eight years in south Africa, F. C. Selous has communicated to the Zoological Society of London the result of his observations on the species of rhinoceros met with there. He distinguishes two; the large, square-mouthed, grass-eating species (*A. simus*), and the smaller, prehensile-lipped form which feeds exclusively on bush (*A. bicornis*). Twenty years ago *A. simus* (*Umhofo* of the Matabele, *Chukuru* of the Bechuanas) was very common in the western half of south

Africa, now it is almost extinct there, and will soon only exist in a few small tracts of south east Africa near the River Sabi.

Although *A. simus* is generally spoken of as the white rhinoceros there is not much difference of color between it and *A. bicornis*. "It is a huge ungainly beast with a disproportionately large head, a large male standing six feet six inches at the shoulder. Like elephants and buffaloes they lie asleep during the heat of the day, and feed during the night, and in the cool hours of early morning and evening. Their sight is very bad, but they are quick of hearing, and their scent is very keen; they are, too, often accompanied by rhinoceros birds (*Buphaga africana*), which, by running about their heads, flapping their wings and screeching at the same time, frequently give them notice of the approach of danger, and are further of service in ridding them of parasites. When disturbed they go off at a swift trot, easily distancing a man on foot, but they are no match for a good horse."

The anterior horn of a full grown animal is from eighteen inches to over four feet in length, a cow having a thinner and usually a longer horn than a bull. Occasionally they are curved backwards, but generally straight and flattened by friction on the anterior surface. The posterior horn may vary from three or four inches to two feet, and there appears to be as much variation in relative length as in individuals of *A. bicornis*.

The prehensile-lipped rhinoceros (*A. bicornis*) (Upeygan of the Matabele, Borele of the Bechuanas) is still fairly numerous in many districts of southeast Africa. Between the Chobe and Zambesi Rivers there appear to be none, but they extend north of that through central Africa into Abyssinia. They feed exclusively on leaves and young shoots, a circumstance which accounts for their presence in many tracts where *A. simus* would be unable to procure its livelihood. These rhinoceroses are very quick and restless in their movements, but Selons acquits them of the surliness and moroseness which most travellers ascribe to them, and considers that there is much less danger in hunting them than in hunting the lion, elephant, or buffalo.

The old Dutch hunters and also the Kaffirs distinguish a third species, which has been scientifically described as *A. keitloa*, and which is characterized by the second horn being equal in length to the first. It is the blue rhinoceros of the colonists and the keitloa of the natives. Selons points out, however, that there are all gradations between the one and the other, while the habits of the keitloa are precisely similar to those of the ordinary black rhinoceros. Both, for example walk and run with their heads high in the air, while *A. simus* carries its head low, and when feeding rubs its anterior horn on the ground, a circumstance which enables one to distinguish an anterior horn of this species from one belonging to the other. Again, the female of *A. simus* guides with her horn her young calf in front of her, while the calves of *A. bicornis* follow their mothers.

For the following description of the habits and modes of hunting of the Abyssinian variety of the African rhinoceros (keitloa) we are indebted to Sir S. Baker's "Nile Tributaries of Abyssinia."

"I had been observing the country for some time from my high station when I suddenly perceived two rhinoceroses emerge from a ravine; they walked slowly through a patch of high grass, and skirted the base of the hill upon which we were standing. Presently they winded something, and they trotted back and stood concealed in the patch of grass. Although I had a good view of them from my present position, I knew that I should not be able to see them in their covert if on the same level; I there-

fore determined to send to the tent for my other horse, and to ride them down. In the meantime I watched the rhinoceroses; both animals lay down in the yellow grass, resembling masses of stone. They had not been long in this position before we noticed two pigs wandering through the grass directly to windward, towards the sleeping rhinoceroses. In an instant these animals winded the intruders, and, starting up, they looked in all directions, but could not see them as they were concealed by the high grass. Having been thus disturbed, the rhinoceroses moved their quarters and walked slowly forward, occasionally halting and listening; one was about a hundred yards in advance of the other. They were taking a direction at the base of the hill that would lead them directly upon the spot where Tétel was tied to the tree. I observed this to Taher Noor, as I feared they would kill the horse. 'Oh, no,' he replied, 'they will lie down and sleep beneath the first tree, as they are seeking for shade; the sun is like fire.' However, they still continued their advance, and, upon reaching some rising ground, the leading rhinoceros halted, and I felt sure that he had a clear view of the horse, that was now about five hundred yards distant, tied to the tree. A ridge descended from the hill, parallel with the course the animals were taking; upon this I ran as quickly as the stony slope permitted, keeping my eye fixed upon the leading rhinoceros, who, with his head raised, was advancing directly towards the horse. I now felt convinced that he intended to attack it. Tétel did not observe the rhinoceros, but was quietly standing beneath the tree. I ran as fast as I was able, and reached the bottom of the hill, just as the wilful brute was within fifty yards of the horse, which now for the first time saw the approaching danger. The rhinoceros had been advancing steadily, at a walk, but he now lowered his head, and charged at the horse at full speed.

"I was about two hundred yards distant, and for the moment I was afraid of shooting the horse, but I fired one of the Reilly, No. 10, rifles; the bullet, missing the rhinoceros, dashed the sand and stones into his face, as it struck the ground exactly before his nose, when he appeared to be just into the unfortunate Tétel. The horse in the same instant reared, and breaking the bridle, it dashed away in the direction of the camp, while the rhinoceros, astonished at the shot, and most likely half blinded by the sand and splinters of rock, threw up his head, turned round, and trotted back upon the track by which he had arrived. He passed me at about a hundred yards' distance, as I had run forward to a bush, by which he trotted with his head raised, seeking for the cause of his discomfiture. Crack! went a bullet against his hide, as I fired my remaining barrel at his shoulder; he cocked his tail, and for a few yards he charged toward the shot, but he suddenly changed his course, and ran round several times in a small circle; he then halted, and, reeling to and fro, he retreated very slowly, and lay down about a hundred yards off. Presently the wounded rhinoceros stood up, and, walking very slowly, followed by his comrade, he crossed a portion of rising ground at the base of the hill, and both animals disappeared. I found the rhinoceros lying dead about two hundred yards from the spot where he had received the shot, and I immediately perceived the companion, that was standing beneath a small tree. The ground was firm and stony, all the grass had been burned off except in a few small patches; the trees were not so thick together as to form a regular jungle. The rhinoceros saw us directly, and he valiantly stood and faced me as I rode up within fifty yards of him. I was unable to take a shot in this position, therefore I ordered the men to ride round a half-circle, as I knew the rhinoceros would turn towards the white horses, and thus expose his flank; this he did immediately, and firing well, exactly at the shoulder, I

dropped him as though stone dead. The number twenty-four bullet had not force to break the massive shoulder-bone, but had merely paralyzed it for the moment; up he jumped, and started off in full gallop. I saw the rhinoceros pelting away about a hundred and twenty yards ahead, and, spurring hard, I shot up to him at full speed, until within twenty yards, when round he came with astonishing quickness, and charged straight at the horse. I was prepared for this, as was my horse also. We avoided him by a quick turn, and again renewed the chase, and regained our position within a few yards of the game. Thus the hunt continued for about a mile and a half, the rhinoceros occasionally charging, but always cleverly avoided by the horse. Tétel seemed to enjoy the fun, and hunted like a greyhound. Nevertheless I had not been able to pass the rhinoceros, who had thundered along at a tremendous pace whenever I had attempted to close; however, the pace began to tell upon his wounded shoulder; he evidently went lame, and as I observed at some distance before us the commencement of the dark-colored rotten ground, I felt sure that it would shortly be a case of 'stand still.' In this I was correct, and upon reaching the deep and crumbling soil, he turned sharp round and made a clumsy charge, that I easily avoided. He stood panting, at bay. Riding Tétel close to his flank I fired both barrels of the little Fletcher into the shoulder. He fell to the shots, and, stretching out his legs convulsively, died immediately.

"The drinking hour is about 8 P.M., or two hours after sunset, at which time the rhinoceros arrives at the river from his daily retreat, which is usually about four miles in the interior. He approaches the water by regular paths, made by himself, but not always by the same route; and after drinking he generally retires to a particular spot beneath a tree, that has been visited upon regular occasions. In such places large heaps of dung accumulate. The hunters take advantage of this peculiarity of the rhinoceros, and they set traps in the path to his private retreat; but he is so extremely wary, and so acute is the animal's power of scent, that the greatest art is necessary in setting the snare. A circular hole, about two feet deep and fifteen inches in diameter, is dug in the middle of his run, near the tree that has been daily visited; upon this hole is placed a hoop of tough wood, arranged with a vast number of sharp spikes of a strong elastic wood, which, fastened to the rim, meet at the centre, and overlap each other as would the spokes of a wheel in the absence of the hub if lengthened sufficiently. We will simplify the hoop by calling it a wheel without a centre, the spokes sharpened and overlapping in the middle. This instrument being fitted neatly above the hole, a running noose of the strongest rope is laid in a circle upon the wheel, the other extremity of the rope is fastened to the trunk of a tree that has been felled for that purpose, and deeply notched at one end to prevent the rope from slipping. This log, which weighs about five or six hundred pounds, is then buried horizontally in the ground, and the entire trap is covered with earth and carefully concealed; the surface is smoothed with a branch instead of the hand, as the scent of a human touch would at once be detected by the rhinoceros. When completed, a quantity of the animal's dung is swept from the heap upon the snare. If the trap is undiscovered, the rhinoceros steps upon the hoop, through which his leg sinks into the hole, and upon his attempt to extricate his foot the noose draws tight over the leg; as the spiked hoop, fixing tightly into the skin, prevents the noose from slipping over the foot. Once caught, his first effort to escape drags the heavy log from the trench. As the animal rushes furiously away, this acts as a drag, and by catching in the jungle and the protruding roots of trees, it quickly fatigues him. On the following morning the hunters discover the

rhinoceros by the track of the log, that has ploughed along the ground, and the animal is killed by lances or by the sword. The hide of a rhinoceros will produce seven shields; these are worth about two dollars each, as simple hide, before manufacture. The horn is sold in Abyssinia for about two dollars per pound, for the manufacture of sword-hilts, which are much esteemed if of this material."

The rhinoceros is sometimes hunted with the sabre, the hunter galloping up behind and severing the hamstrings. Unlike the elephant the rhinoceros can walk on three legs, so one cut does not disable him. The Abyssinian form (keitloa) measures only five feet six to five feet eight inches at shoulder. The power of scent is so good that it detects a stranger at five hundred or six hundred yards. Baker observes that a rhinoceros will generally charge down upon the object that it smells but does not see, rushing with three loud whiffs resembling a jet of steam from a safety valve. In thick jungle such a charge may be very unpleasant. The cry is insignificant, not unlike the harsh, shrill sound of a penny trumpet.

The genus *Ceratorhinus* differs from the African forms and agrees with the following genus in the arrangement of the teeth. It possesses two horns, and although its skin is not folded into shields as in the rhinoceros, yet the marking off of a distinct cape over the shoulder, and a similar if less distinct fold on the haunch, indicate that the two species to be now described occupy in this respect a position intermediate between the African and Indian forms. The internal anatomy bears out this view of the generic distinctness of the Sumatran rhinoceros. The best known species, *C. sumatrensis*, is not confined to Sumatra, but is found in Borneo as well as on the Malaccan peninsula. The skin is of a dark slate color, thinly covered with black hairs more than an inch long, situated mostly on the back and outsides of the legs. The entire length is about eight feet, exclusive of the tail, which measures twenty-two inches. The ears are lined with black hairs not merely fringed, and there is no gland at the back of the feet as in the Indian rhinoceros.

C. lasiotis, recently separated as a distinct species by Mr. Sclater, is perhaps a northern representative of the Sumatran species, being found in Chittagong and Assam. It differs from it in various important points, being taller by six inches at the shoulder, and having a smoother and paler skin. The ears have a distinct hairy fringe, and are much wider apart, while the tail is shorter and terminated by a tuft of long brown hairs. The general color is light brown, owing to the rufescent hairs which are longer and finer than in the allied species.

The one-horned species of rhinoceros form the genus *Rhinoceros* in the narrower sense of the term, and includes two species, *R. indicus* and *R. sondaicus*. The former appears to be confined to the Terai region of Nepaul and Bhootan and to the upper valley of the Brahmapootra in Assam. It is one of the largest species, attaining a length of ten feet six inches, and half that height at the shoulder. The skin is folded over into a complete series of shields, each of which is again marked off into tubercles of an irregularly round outline. From between these tubercles arise, especially in young animals, the few coarse hairs which the animal possesses. The skin on the hinder parts of the cheeks may possess tubercles of greater size, occasionally in older animals of almost horn-like appearance. A folded collar surrounds the neck and hangs down into a rigid dewlap below. Over the withers is a single shield of somewhat triangular form, the point projecting backwards; above each fore-leg is another of similar shape, arranged in such a manner as to form a cape over the neck and shoulders. The trunk is covered with the thick skin marked off into tubercles, but the hind-



Rhinoceros indicus, Indian rhinoceros.

quarters have each a heavy shield hanging down as far as the knee-joint, and sub-divided near the top by a less deep longitudinal fold running towards the root of the tail. The tail is sparingly haired towards the extremity, the hairs being coarse and bristly like those on the margin of the somewhat long and narrow ears. The horn may attain a length of three feet, but is generally less in the specimens found in captivity. Selater has recorded that, in the Zoological Gardens in London, a male and a female rhinoceros of this species were placed in adjoining enclosures, and the male, in the course of his attempts to tear up the strong iron railing separating him from his companion, tore off his horn. Although the result was evidently painful, and was accompanied by a considerable flow of blood, still a new horn began to replace the old one. It is not to be doubted that such reproduction of a lost horn may also take place in nature, giving rise in certain cases to horns of abnormal form. Selater also states that an old female which had been a long time in the gardens had, by always working at the bars of her cage, caused the horn to grow straight forwards instead of upwards.

The Javanese species, *R. sondaicus*, is much smaller than the other, from which it is distinguished by a separate saddle-shaped shield over the nape of the neck, behind which is the cape over the withers and shoulders. The upper lip is also much larger and more extensible. It was formerly thought to be confined to Java, but is now known to extend north into British Burmah, and the Sunderbans of Bengal, as well as into Borneo.

A Malay offered Mr. Bock, in Borneo, a fine specimen of one of the horns of this species, for which he wanted eighty florins. This fancy price was occasioned by the demand which exists for rhinoceros horns among the Chinese, who use them as medicine, or rather ointment for healing wounds, and especially snake bites. The horns of other species appear to be regarded with great respect in various eastern countries, as drinking-cups made of them are said to show at once the presence of poison in the cup.

Although the living species of rhinoceros are so few in number and so limited in their geographical distribution, such was not the case in former geological periods. Professor Cope recognizes some twenty-seven fossil species, of which more than half ranged through North America in miocene times. All probably descended from tapir-like Lophiodontidæ, which are abundant in eocene strata both in Europe and America, and the genus *Triplopus* of Cope, from the upper eocene of Wyoming, was likely a link in the chain of descent.

One of the earliest European rhinoceroses, *Aceratherium*, from lower miocene strata, had four toes on the fore-feet, and no horn. *Cænopus*, from the White River formation, is the nearest ally of that genus, but has only three toes on the fore-feet. *Aphelops*, from higher miocene strata, had not yet acquired the horn, but possessed the reduced number of teeth characteristic of the more recent rhinoceroses. The *Dicera-therium* of Professor Marsh, one of the earliest of the American genera, had a tuberosity for a horn on *each* nasal bone,—a peculiarity inherited from some of the tapir-like eocene ancestors, but not transmitted to any more recent forms. The rhinoceroses died out in America at the end of the miocene period; not so, however, in the old world, for, apart from the living species described, three, belonging to a distinct genus (*Cœlodonta*), in which the septum of the nostrils was more or less ossified, ranged over the whole of Europe and North Asia in pliocene times. One of these, *R. antiquitatis* or *tichorhinus*, persisted after the mammoth, and every now and then in Siberia more or less well-preserved frozen carcasses of this extinct animal

are found. The most recent find of this sort was in 1877 on a tributary of the Jana, where a complete carcase of an immature animal was unearthed. All the tissues were much dried up, except a thick layer of fat underneath the skin. The head only and a hoof were preserved. This species is sometimes known as the Woolly Rhinoceros from the abundant hair. The front half of the head is covered with thick short hair, but the hinder half, the ears and neck, bear wool, in which stiff hairs from one to two inches in length were intermingled. The general color of the coat varied from fawn color to reddish-yellow. Remains of grass-like food were found between the teeth. There is no prehensile upper lip like what we have seen to be characteristic of all the living forms except the African white rhinoceros. This species further resembles the African congener in having two horns, and no dermal shields on the trunk. An allied form, *R. merki*, is found under similar circumstances, an entire carcase having been recently discovered near Werknejansk, East Siberia.

The family EQUIDÆ, including the horses, asses, and zebras, although now confined, as far as its wild representatives are concerned, to Asia and Africa, was nevertheless at one time widely spread over the surface of the globe, and it has been possible for American palæontologists, with the rich fossil remains in our pliocene and miocene strata, to construct a complete pedigree leading back to the Palæotheridæ. The following particulars are characteristic of the living members of the family.

The skin is soft and hairy, with the exception of the horny patches (chestnuts) on the inner surface of both, or only the fore, pairs of legs; and those behind the joint between the metapodial and pastern bones (the ergot or spur). The hair forms a mane on the neck, and a more or less bushy tail. The weight of the body is supported upon the third toes alone in both fore and hind feet (hence "Solidungula" and "Solipeda"), the terminal joints of these being broadened out into a 'coffin' bone which is clad with the hoof. The so-called 'splint bones' are the only representatives of the second and fourth toes, and are the upper ends of the metacarpals and metatarsals of these, the joints of the toes not being present at all. The metapodials of the third toes are so extremely long that the wrist and ankle joints form about the middle of the leg, and are known respectively as the 'knee' and 'hock.' The outer bones of the fore-arm and leg, the ulna and fibula, can hardly be said to enter into the formation of these joints, for only their upper ends are distinctly separate, while the lower are fused with the radius and tibia. The peculiar form of the joints of the third toe has introduced several terms into veterinary anatomy; thus the first joint is the 'pastern' or 'fetter' bone, the second the 'coronary,' and the last the coffin bone. Behind the metapodio-phalangeal joint, are two sesamoid bones, and behind that between the coronary and coffin bones, a third, the so-called navicular. The hoof closely surrounds the coffin bone; its dense part, the 'wall,' is only formed on the anterior and lateral surface of the bone; the greater part of the under surface is covered by the 'sole' bounded by the wall externally. The 'frog' is a horny mass projecting towards the sole between the 'bars' of the wall, diverging behind to the heels of the frog, which are continuous above and at the sides with the 'coronary frog-band.' The skull is much elongated and the lower jaw much elevated behind. The milk teeth are arranged according to the following formula, $i. \frac{3}{3}, c. \frac{1}{1}, m. \frac{4}{4}$; of the grinders the first milk grinder is not replaced by a permanent molar, so that the adult formula is $i. \frac{3}{3}, c. \frac{1}{1}, m. \frac{8}{8}$. The upper canines in the adult are late of development and may not appear in the mare. There is a wide diastema (gap

where the bit lies) between the canines and the grinders in both jaws. The incisor teeth are peculiar in having a fold of enamel pushed in from the surface, like the point of a glove finger turned in, the cavity of which fold is filled with cement and discolored particles of food. When the surface of the tooth is worn there is consequently an inner ring of enamel round this central cavity; this constitutes the mark by which one may tell the age of a horse, for when all the incisor teeth are worn below the level of the fold, which occurs about the eighth or ninth year, the mark disappears and the horse is aged. The outermost of the permanent incisors does not push out its milk predecessor until the fifth year, and it is when these teeth, the 'corner nippers,' rise to a working level that the 'colt' becomes a 'horse' and the 'filly' a 'mare.' The molar teeth of the horse are characterized by their great length before they divide into fangs; the surfaces have folds of enamel like the incisors, but the walls of the folds are much plaited, so that when much worn down the enamel line and the surfaces outside and inside it have a very complex form.

The above are some of the most important features in which the Equidæ differ from the foregoing families of Perissodactyla. It is well to remember that all of them are specializations adapting the animals to speedy locomotion on dry land, and to the change of food which a life in deserts and elevated plateaus brings with it. Such changes have necessarily otherwise affected the habits of the animals. Their safety on the plains on which they dwell is insured by their gregarious habits, by their acute sense of hearing, and by their being able to warn their comrades with a loud, sonorous neigh, or a harsh bray. The herds are often of large size, formed of numerous families, associated for mutual protection, which are composed of a leading stallion and as many mares as he can keep with him. The foaling time is generally in the spring of the year, the female carrying her young for eleven months. The foals are weaned at five or six months, are able to propagate themselves at two years, and become adult about five. The various species have been artificially crossed by man, and are found to be fertile with each other. The offspring are generally sterile, although such is not always the case. Without the intervention of man such crossing would not occur, for it has been observed among the wild horses of South America that the members of different herds do not readily mingle with each other, and in fact show a marked distaste for each other's society.

Our space does not suffice for an extended account of the natural history of the horse, but we propose to sketch briefly the circumstances which appear to have operated in forming so many different breeds, as well as to make some reference to the fossil progenitors of the family before discussing its various living members. First, a few words as to their mental characteristics. Although, as was remarked above, the brain of the horse is small, yet all the members of the family are possessed of considerable sagacity and intelligence, and a tenacious memory. The emotional side of their nature is likewise largely developed, for the anxiety to be first in a race, their conduct in the battle-field, their susceptibility to kindness and resentment of injuries, all point to this. Such is their natural timidity, that we learn from travellers in South America that sometimes, impelled by fear, large herds will rush madly on, in one direction, often to their own destruction. Fear, also, is no doubt the chief agent in the process of taming, at any rate of that rough process of taming which is practised by the gauchos of South America. Mr. Romanes, in his "Animal Intelligence," narrates several incidents pointing to great sagacity in the animal, such as the case of a Shetland pony going to be shod of his own accord, after dropping a shoe; a Canadian horse saving

a woman from drowning by holding her gown in his teeth; and several instances of horses overcoming obstacles to the oat-bin. Arabians, in the desert, have been known to stand by their fainting owners, and neigh for assistance; and narratives as to their affection for their owners and attachment to other animals are known to everybody.

The horse was probably first domesticated in Asia, but the first historical mention we have of it is from monumental records in Egypt dating about 1900 B. C., a date long after the introduction of the ass there. As at present, in Arabia, the heavier labor of carrying burdens is relegated to asses and camels, so also in historical times we find the horse principally employed for carrying his owner and for military purposes. The influence of man was probably exerted from the very first towards securing an increase in size, and the extent to which that has taken place, if we compare the domesticated animal with his nearest wild relative, is sufficient to indicate the exceedingly plastic organization of which he is possessed. Much of this artificial selection was no doubt unconscious, for the science of horse-breeding is of comparatively recent growth.

Climate and food have evidently co-operated in modifying the horse. It is universally observed that the horses of southern countries, accustomed to dry, and sometimes scanty food, are capable of much greater speed than those of more northern countries, where the atmosphere is moister and the herbage ranker. There speed gives place to strength, and consequently the heavy draught horses are the natural product of such countries. Flanders was at one time the source of the heaviest and most powerful animals, and the French Percheron breed is valued at the present day for similar qualities. Although capable of enduring great cold, yet we find the horse deteriorates in size in countries still further to the north, so that the native ponies of Britain and Norway, and especially of Shetland and Iceland, are very diminutive. One can hardly believe it possible that the huge dray-horse and the Shetland pony are descended from a common source, and yet we are everywhere met with striking proofs of the extreme variability of the horse under different natural conditions, and under artificial selection. Not less singular is his adaptability, for the conditions under which the 'thoroughbred' horse exists in northern countries are totally different from those natural to the oriental breeds which gave rise to them.

Many of the best horses are bred on the confines of Arabia, near the Euphrates, but the Bedouins of the interior also possess very fine animals. Palgrave, one of the most recent travellers in Arabia, gives an interesting account of his visit to the royal stables in Nejed, the birthplace, according to him, of the primal type of the Arab steed. A light iron ring surrounds the pastern of one of the hind-legs of each horse, and is secured to a peg at some distance by an intervening chain and rope. Should the animal be restless a fore-leg is put under similar restraint. Arabian horses, although spirited, are nevertheless much more gentle than those of Europe; a fact which probably accounts for the few geldings met with. Their stature is somewhat low, — on an average little over fourteen hands, — but the animals are exquisitely shaped, full in the haunches, with beautifully shaped shoulders, clean, sinewy limbs, tapering nose, full eye, and small ear. No prolonged lists of pedigree are kept, all inquiries about race being limited to the assurance of a good father and mother. These horses are never sold, are possessed only by chiefs or individuals of considerable wealth and rank, and only change hands in the course of war, or through a legacy or gift. They are exceedingly fleet and enduring, will pass forty-eight hours under a

Shetland pony.



burning sun without drinking, and are furthermore extremely sensitive and obedient to the wishes of the rider, although ridden without bit or bridle.

Eastward and southward of Nejed the race deteriorates, the horses met with in the eastern angle of Arabia being more like those found in India. To the north, in Jebel Shomer, the horses are still fine, being generally half Nedjed, but as Syria is approached the animals lose in general appearance, although they gain in strength and size. The Turks, from which the English racehorse is partly descended, were mostly imported from Smyrna and other ports in Asia Minor. Throughout the whole of that district, as far north as the Caucasus and eastward towards and beyond the Caspian, are to be found magnificent horses, mostly the property of Circassians, Kurds, and Turcomans. Of the African races the Nubian differ most from the Arabian, in attaining a higher stature while being considerably shorter, but the "Barbs," from the district north of the Sahara, are as elegant and as spirited as the Arabians. It is to the judicious crossing of the Barb and Turk, with the subsequent careful system of breeding, that England owes its thoroughbred race-horse, and the horses of most European countries, as well as of North America, have been much improved by the infusion of thoroughbred blood.

The horses of Spain, probably on account of the admixture of African blood, were at one time very celebrated, the Spanish jennets having much of the high action of the Barbs. They no doubt contributed to giving to the horses of more northern countries that elegance and speed which we have seen is not natural to moister districts, where herbage is abundant. It is said that the horses on board the ships of the "Armada," which were stranded on the coast of Ireland and on the northern islands, have left direct descendants behind them in the Connemara horses of the Galway coast, and that the Shetland pony is indebted to them for much of its spirit and fleetness. Of course both breeds have a shaggier coat, in adaptation to the colder and moister climate, than the Andalusian progenitors. The new world is largely indebted to Spain, at any rate as far as South America and Mexico are concerned, for its horses; a further interest attaches to these on account of the wild state to which they have reverted.

The American fast-trotting horse is an instance of what careful selection will do in a comparatively short space of time. As Mr. W. H. Brewer points out, fast trotting is not natural to the horse, but various circumstances conduced to a gradual improvement of this gait, such as the sentiments that formerly existed in New England regarding horse-racing, the fashion of wealthy men driving single fast trotters, and the improvement in carriages and roads. All these factors co-operated in the development of a new breed of horses, so that between 1818, when records began to be systematically kept, till 1883, the time for a mile heat has been gradually improved from three minutes to two minutes, ten and one-quarter seconds.

One of the most interesting phenomena in the natural history of the horse is the readiness with which it reverts to the wild state under suitable conditions. Such feral horses are abundant in South America. They are supposed to have descended from five Andalusian horses and seven mares which were turned out of Buenos Ayres when the colony was deserted in 1537, shortly after its foundation. They increased so rapidly, that by 1580 they had reached the Straits of Magellan, and also made their way northwards into Paraguay. Most of them are of the chestnut-bay color of their progenitors, but paler hues are occasionally met with. The effect of the free life has been to increase the size of the head, the length of the ears, and the thickness of the

joints, as well as to alter the character of the coat. The Gauchos readily catch them by means of the lasso and bolas, and the mustangs thus tamed become very hardy and serviceable horses. The same state of affairs has occurred, though to a less extent, in Mexico, and other instances are not wanting. Thus on the Falkland Islands are both wild horses and wild cattle: the former have deteriorated in accordance with the principle already explained, — that island life causes a reduction in the size of horses.

Apart from such changes as may be traced to the return to freedom, 'reversions' to what may be regarded as the ancestral type are not rare among domesticated stock. Such is the assumption of dun-color, which, although infrequent in pure-bred horses (an Arab despises a dun horse), is nevertheless of very common occurrence. Very often neither of the parents are dun, so that we are forced to find an explanation in 'reversion.' It is noticed to be most frequent among horses which lead a comparatively untrammelled life, such as the horses of Norway and of the Dartmoor Forest, England, and the horses of North India. A dark spinal stripe, occasionally accompanied with one or more shoulder stripes, is often evident, especially in dun-colored foals. Dappling is regarded by Darwin as an indication that the horse is descended from an ancestor striped after the fashion of the zebra. The spots are nothing else than the rudiments of formerly continuous stripes. Reversions of a more abnormal and striking character are also recorded. Thus horses are occasionally born with horn-like projections on the frontal bones, a phenomenon which no fossil remains have yet explained to us. Another reversion, more familiar especially at county fairs, is the possession of one or more extra hoofs, which, of course, means extra toes. This phenomenon of 'polydactylism' is, however, easily explained by reference to the fossil progenitors of the horse, which we shall now take the opportunity of doing.

Professor Marsh has gone into several cases of these extra hoofs, and finds that it is generally the inner toe (the second) which, instead of being merely represented by the ordinary splint-bone, has a complete metacarpal or metatarsal, the full number of joints to the toe, and the last of these clad with a hoof, which, however, rarely reaches the ground. He traces the pedigree of the horse through several polydactyle forms back to the beginning of the tertiary period, notices a gradual decrease in size as the toes increase in number, and that the molar teeth decrease in complexity. "If, now, we turn back to the early ancestors of the horse for an explanation of the supplementary digits which so often make their appearance, we shall not look in vain, especially in this country. America is the original home of the horse, and during the whole of tertiary time this continent was occupied with equine mammals, of many and various forms. Although all these became extinct before the discovery of this country, their abundant remains mark out the genealogy of the horse in an almost unbroken succession of forms.

"The original ancestor of the horse, not as yet discovered, undoubtedly had five toes on each foot. The oldest member of the group now known is the *Eohippus*, which had four well-developed toes and the rudiment of another on each fore-foot, and three toes behind. This animal was about as large as a fox, and its remains are from the Coryphodon beds, near the base of the eocene. In the next higher division of the eocene another equine genus, *Orohippus*, makes its appearance. It resembled its predecessor in size, but had only four toes in front and three behind. At the top of the eocene a third allied genus has been found, *Ephippus*, which closely resembled *Orohippus* in its digits, but differed in its teeth. Near the base of the next formation, the miocene, another equine mammal, *Mesohippus*, occurs. This animal was

about as large as a sheep, and had three usable toes and the splint of another on each fore-foot, with but three toes behind. At a somewhat higher horizon, a nearly allied genus, *Miohippus*, or *Auchitherium*, has been found, which has the splint bone of the outer, or fifth, digit reduced to a short remnant. In the pliocene above a three-toed horse, *Protohippus*, or *Hipparion*, about as large as a donkey, was abundant; and still higher up a near ally of the modern horse, with only a single toe on each foot, *Pliohippus*, makes his appearance. A true *Equus*, as large as the existing horse, appears just above this horizon, and the series is complete."

The members of this family were separated by Gray under two genera, *Equus*, including the various breeds of horses proper (*E. caballus*), as well as the wild tarpans, to be afterwards referred to, and *Asinus*, embracing the various species of wild ass, the domesticated varieties, and the African zebras. The diagnostic characters of *Asinus*, as compared with *Equus*, he found in the absence of callosities on the hind legs, the presence of a dorsal darker-colored stripe, and in the tail being bushy only towards its extremity. Apart from the fact that a dorsal stripe is present in some horses, and that the quagga and Burchell's zebra have an equine tail, a new wild species has recently been described by M. Poliakof, which renders this subdivision untenable. This form, named *E. przewalskii*, which was recently found in the sand deserts of central Asia, shares the four callosities of the horse, although its tail approaches in form that of the ass, being only partially furnished with hair; it is, further, destitute of a forelock, and has a short mane. M. Poliakof's paper contains some further information regarding the various wild species of the horse in Asia. Before giving our readers the benefit of his investigations, we may with advantage introduce an account of these forms, leaving for future consideration the characteristic South African striped species. It is necessary to observe that the views of naturalists as to the specific distinctness of the Asiatic Equidæ are greatly at variance with each other, and that a good deal of confusion in the nomenclature has accordingly arisen.

North of the Sea of Azof, in the steppe country, lying between the River Dneiper and the Caspian, are still to be seen large herds of wild horses, of small size, dun color, short mane, and rounded, obtuse nose. These are called Tarpans by the inhabitants, who do not doubt that they are really wild, and who hunt them in the spring when the ground is in a condition to allow of easy approach. The herds are composed of small families, led by a stallion, and appear to have much the same habits as the kulan, to be next described. Whether they are really wild animals, or are only descendants of horses which have escaped from ownership, is not settled; but there is, at any rate, an infusion of the domesticated stock, for mares are frequently enticed by the tarpan stallions to join their herds. Pallas believed that the tarpans are merely 'feral,' and that they are descendants of horses which were turned out to provide for themselves after the siege of Azof, at the close of the 17th century.

Further eastwards are found three forms, which are known as the kulan, the djiggetai, and the kiang. These are regarded by George and Brehm as unquestionably the same animal, which would thus have a range from the Kirghiz steppes, along the north of the Himalayas, to the Chinese frontier. Poliakof, on the other hand, is disposed to look upon them as distinct species, and at any rate as well marked geographical varieties; of these the Kulan (*E. onager*) has the widest range, — from the Aralo-Caspian steppes to Dzungaria (Than Shan Petoo), — while Pallas' typical specimens of the Djiggetai (*E. hemionus*) were obtained in southern Dauria, to the north of that sea of sand which constitutes the Desert of Gobi. The Kiang

(*E. kiang*) is only found in the mountainous regions of Thibet. In coloring and the length of its ears it comes nearer to the domestic ass than the kulan or djiggetai, but it is larger, and lacks the transverse shoulder-stripe. The ash gray of the upper parts is sometimes marked with a reddish tinge, but the under parts are white, as is also the end of the muzzle. The hoofs are longer and narrower than in the kulan and djiggetai. The two latter are certainly closer to each other than they are to the kiang: it is very probable that further researches will show that they are only varieties of the same



FIG. 127. — *Equus onager*, kulan.

species. Brehm, who has had the opportunity of observing them in their native homes, describes both them and the kiang under the one specific name, *E. hemionus*; and Mr. George even extends this to the Syrian wild asses and those of Cutch.

The specific name *hemionus*, "half ass," was given to the kulan by the Greeks, on account of its stature, which is between that of the horse and ass, and nearly that of a mule. They measure upward of eight feet in length, and stand some four feet and six inches or five feet high at the shoulder: the head measures twenty, and the tail sixteen inches in length. The coat is grayish in winter, but assumes a fulvous hue in summer;

the face and under parts are somewhat paler, and a dorsal brown stripe extends from the mane along the tail, widening over the croup. The mane is soft and bushy, but has the hogged appearance characteristic of the zebras. In their habits they resemble the tarpans, above referred to, are shy, untamable, extremely swift and difficult of approach, live in families of six to twenty, led by a single stallion, who acts as sentinel for the family, and has frequently to assert his proprietary rights by fights with less successful stallions. The kulans are not stationary, but migrate in the spring and fall to more suitable pasture grounds. The foaling time is in early summer, and the period of gestation eleven months. They have frequently been bred in zoological gardens, and successfully crossed with most of their congeners.

The foregoing resumé of the wild horses of Asia will enable our readers to understand M. Poliakov's account of the supposed new species.

"The hunting expedition sent by M. Tihouof from the post Zaisan to the sand deserts of Central Asia, in quest of wild camels, obtained another interesting animal, hitherto unknown to science. This was a new species of the equine race, identical with the 'Surtakeh' of the Kirghiz, if we may judge from Dr. Brehm's information, collected from the Kirghiz inhabiting the tracts where the wild camel is known to exist. One single specimen was shot by these native hunters, and its skin was preserved and sent as a gift to Przewalsky, who happened to be then at Zaisan. He presented it to the zoological museum of the Academy of Sciences, under the designation 'tarpan.' After the donor I have named this species of horse *Equus przewalskii*; but, though more nearly akin to the domesticated horse than to any variety of wild ass existing in Asia, it is distinct from the tarpan, or wild horse of travellers and explorers of the last century. Indeed, the information regarding the tarpan collected by Rytchkof, Gmelin, George, and Pallas is of so contradictory and confusing a nature that many zoologists have decided that the so-called wild horses, or tarpans, were not, strictly speaking, wild, but tamed horses which had resumed their wild state on recovering their liberty.

"A similar opinion was expressed by M. Bogdanof, at a meeting of the Society of Naturalists of St. Petersburg; and Pallas was disposed to take the same view when he assumed the feral horses, or tarpans, in Tartar-Kirghiz dialect, roaming over the steppes of the Jaik and the Don, as well as on that of Baraba, to have originated from domesticated horses owned by Kirghiz Kalmuks, or other wandering tribes, and to have become wild. Elsewhere, however, Pallas does not speak of the tarpans (*Equus equiferus*) in the same way, but merely states that there had been an intermixture, wild stallions having covered domesticated mares separated from the herd.

"Ecker, in a recently published work, accepts the tarpan as the true typical representative of the wild horse, resembling in every particular the animal which, in his opinion, was indigenous at a period of remote antiquity in various parts of Europe, and became subject to man in prehistoric times, probably in the stone period. Ecker finds a striking resemblance between the tarpan and the wild horse of the caves of Solutré (near Mâcon), particularly in regard to size of body, head, etc. Unfortunately we have no reliable information on this legendary tarpan since the end of last century, and the testimony of the above-mentioned explorers is merely conjectural. In any case the animal I have named *Equus przewalskii* cannot be the tarpan, as described by Rytchkof, Gmelin, Pallas, and others. Rytchkof describes the tarpan as equal in size to an average horse, but rounder in shape, color dun or bluish, other shades exceptional, with larger head than the Kirghiz horse.

"Gmelin remarks that the largest of the wild horses is scarcely to be compared, for size, with the smallest of domesticated breeds. The head is very large in proportion to the rest of the body; the ears are pointed, and either of the same size as those of the domesticated animal or long and pendulous like those of the ass; the eyes are fiery, the mane very short and curly; the tail in some instances thick, in others scanty, and always shorter than in the domesticated animal; the color is invariably that of the mouse, with an ashy shade underneath the belly, whilst the legs, from the knee downwards, are black; the coat is long and thick, more like fur to the touch than horse-hair. From these descriptions of the tarpan, or wild horse, by Gmelin and Pallas, it is evident they were unacquainted with *Equus przewalskii*, and Rytchkof had, perhaps, only accidentally heard of it when he mentioned a horse of dun color. As to tarpans of blue and other colors, mentioned by Rytchkof, they were such as had probably resumed a feral state in the same way as those described by Gmelin and Pallas. If it could be proved that *Equus przewalskii* had ever been indigenous further west, and if when crossed with the domestic breed, unlike all the asinine tribe it produced a fruitful progeny, some secrets in the history of our domestic horse might be brought to light, a conjecture partly confirmed by Rytchkof himself when he refers to the dun-colored tarpans in the neighborhood of Jaik, in company with blue and other colored tarpans. It also gathers consistency from the testimony of Pallas as to the habit of tarpan stallions, although in this instance not of pure breed, to entice mares away from domestic herds; and if from this intermixture of blood were born descendants, these may have shown marks characteristic also of *Equus przewalskii*. To these may be referred the characteristic of the mixed breed noticed by Gmelin, viz., 'legs from knee to hoof black.' The converse might also occur, as stallions from half-wild troops owned by the nomads of Asia might entice mares from the wild herds, and a peculiar mixture of color and breed would result from this union. It may be considered very probable that *Equus przewalskii* would give parentage to a fruitful progeny when intermingled with the domestic animal, and perhaps the wild herd of parti-colored tarpans was the result of this cross-breeding. On the other hand, it is also probable that the domestic horse, varying in color, size, and shape, is the descendant of a variety of wild, now extinct breeds. That *Equus przewalskii* may have been indigenous further to the west, not only on the Jaik or Ural of the present day but even beyond, in northeastern Europe, is highly probable, judging from the history of its companions in the steppes of Central Asia.

"The saigak antelope, in the diluvial epoch, was met with at the Carpathians, where its bones have been discovered, together with stone implements, in caves. Remnants of the skull of a saigak have also been found in the Volga valley near Sarepta. Not longer ago than the end of the last century the saigak was very numerous in West Siberia; and Pallas mentions having seen herds of this antelope on the Irtysh below Semipalatinisk, where it is now never met with and has been completely forgotten. It is even rare at the present day in the environs of Lake Balkash, where not long since it was as numerous as the kulan, large herds of this last-named animal having in Rytchkof's time roamed near the Jaik. In my last excursion to Balkash, during several days passed in its solitudes I did not observe a kulan, and only saw the tracks of one imprinted on the saline soil. These animals still exist in large numbers in the little-inhabited steppes of eastern Dzungaria and western Mongolia. A similar fate has probably befallen *Equus przewalskii*, whose habitat has now been discovered to be the same as that of the saigak, the kulan, and wild camel. If this horse was indigenous

at any time further to the west and became closely allied to the troops of domesticated horses owned by the nomads, it would of course be the object of the keenest pursuit, and would the sooner disappear from its earlier habitat. But there exist herds in more remote parts of Asia called wild by Colonel Przewalsky. 'Wild horses, called by the Mongols dzerlik-adu, are rare in western Tsaidam, but more numerous near Lob-Nor. They are generally in large herds, very shy, and when frightened continue their flight for days, not returning to the same place for a year or two. Their color is uniformly bay, with black tails and long manes hanging down to the ground. They are never hunted, owing to the difficulties of the chase.' One specimen of *Equus przewalskii* is about three years of age; in size it is no bigger than the kulan and djiggetai; its head is nearly of the same length as that of those animals, but lower and better shaped near the end of the muzzle and nasal bones, with shorter ears than those of the wild ass. Its size is decidedly small in proportion to its head. In shape it takes after the horse; its legs are relatively thick for the size of its body, its hoofs rounder and broader, and its tail better furnished with hair than in the case of the wild ass. Its color is dun, with a yellowish tinge on the back, becoming lighter towards the flanks, and almost white under the belly. Its hair is long and wavy, brick-red on the head and nasal bones; of the same color but longer on the cheeks and about the lower jaws. The extremity of the nose is covered with almost white hairs, a remarkable contrast to the brick-red on the upper part of the head. A short, upright (hogged) mane extends from between the ears to the withers, of a dark brown color, with long yellowish hairs on the margins. It has no stripe of the same color as the mane along the back, as all Asiatic asses and dun horses have, and a hardly perceptible one along the pelvis. The upper half of the tail is of the same color as the back; it is longer, thicker at the root, and more bushy than that of any kind of ass; half way down the tail yellowish hairs are mixed with the brown, and the extremity is dark brown or nearly black. The fore-legs are brown near the hoofs and on the knees, and oblique indistinct bars of brown hair extend down the legs. The prevailing color of the lower part of the fore-legs is brown, a peculiarity never known to occur with wild asses, these having only a narrow, barely-distinguishable, brown margin round the upper rim of the hoof. Dark hairs also occur on the hind-legs about the hoofs and much higher."

From our account of these various Asiatic forms it will be seen that the origin of the domesticated horse still remains obscure; the further study of the new species here described may, however, lead to further revelations touching this interesting point. Powakof's account of *E. przewalskii* concludes with the following suggestions: "The congeners of *Equus przewalskii*, occupying an enormous extent of territory in Europe and Asia, as we are led to infer from their fossil remains, may have been still more varied and multiform; and the first to be tamed were probably those on the outskirts of the great barren steppes, inhabiting well-watered and hilly tracts near one or other of these land-locked water basins, the earliest abodes of primeval man. In such regions in Siberia fossil remains of the stone period have been discovered by me and other explorers, whilst the outlying mountains of the Tian-Shan and Pamirs will doubtless afford many more. The primeval horse indigenous in these localities may have been more easily brought under subjection than its fellows in the steppes, and may have presented some such relationship to our *Equus przewalskii* as exists between the kiang and the djiggetai and kulan. Afterwards descending with man from the more favored hilly region, they may have together entered the plains, where human activity appears to have been of a more recent date, probably in the bronze and iron period.

But however this may have been, *Equus przewalskii* is the sole wild species having close affinity with the horse (our domesticated *Equus caballus*)."

Although the origin of the horse is thus still a matter for further research, naturalists are agreed that no such difficulty exists concerning the ass. Two forms of wild ass are known (those of Syria and Africa), which may be distinct species or only geographical varieties, but there is no doubt that both of these may be caught



FIG. 128. — *Asinus tanius*, African wild ass.

and tamed very easily, that the wild ones are frequently used for improving the domesticated stock, and that the ass in countries at a distance from the home of these species is probably due to an intermixture of both. All are characterized by the transverse shoulder stripe, the long ears, and by the extremely harsh bray; the latter is especially heard at breeding-time, and among the wild forms serves to apprise their comrades of danger.

The Syrian Wild Ass, according to Brehm the Onager of the ancients, (*E. hemippus*), stretches from Syria through Arabia and Persia to India. Smaller than the

kulan, which it resembles in its habits, it is nevertheless considerably larger than the common ass. It approaches the latter in the greater size of the head and length of the ears, but its noble carriage, cleaner limbs, and finer coat sufficiently distinguish it. The coat is silvery white, tending towards a pale fawn color on the sides. The dorsal stripe is brown, and the transverse shoulder stripe is also present.

The Indian Ghur-Khur, or wild ass of Cutch, has sometimes been described as distinct (*E. indicus*), but Sclater has no doubt of its identity with the Syrian form; in fact he considers both these and the domesticated animals to have descended from the following species, and consequently regards Abyssinia as the centre of distribution of the ass.

The African Wild Ass, *E. tæniopus*, inhabits the tract of country lying between the Nile and the Red Sea. It does not seem to be confined to any particular sort of ground, but occurs in the highlands of Abyssinia as well as in the desert plains towards the north. The species is sufficiently distinguished by the marked transverse shoulder stripes, and the indistinct rings on the legs. Sir S. Baker, in the accounts of his travels through this part of Africa, refers frequently to the wild asses, as well as to the domesticated breed, which is unquestionably derived from them, and which is very largely employed for transport. In reference to the wild ass, he says:—

“Those who have seen donkeys in their civilized state have no conception of the beauty of the wild, or original animals. It is the perfection of activity and courage, and has a high-bred tone in the deportment, a high-actioned step when it trots freely over the rocks and sand, with the speed of a horse when it gallops over the boundless desert. His color is reddish-cream, tinged with the shade most prevalent of the ground that it inhabits. Thus it much resembles the sand of the desert.

“I shot one fine specimen, a male, in excellent condition, although the miserable pasturage of the desert is confined to the wiry herbage already mentioned; of this the stomach was full, chewed into morsels like chopped reeds. His height was about 13.3 or 14 hands, the shoulder was far more sloping than that of the domestic ass, the hoofs were remarkable for their size, width and firmness, being as broad as those of a horse of fifteen hands.”

The flesh of the African wild ass is appreciated as food just as much as is that of its Syrian congener. Not so the domesticated animal; it would appear sometimes not to be so clean a feeder as the wild form, for Baker narrates a case where his asses developed scavenging propensities, and another where they prospered on antelope flesh when herbage was scarce.

The Ass (*E. asinus*) was probably one of the first quadrupeds subjugated by man. Lenormant states that it was employed by the ancient Egyptians from the earliest monumental times, the horse not having been introduced till 1900 B.C. An explanation of this fact is afforded by the ease with which the wild ass may be tamed, and the entire change of nature which it undergoes when deprived of liberty. This change involves a loss of spirit, which is often exaggerated by ill-treatment in northern countries, where the ass is chiefly the property of the poorer classes.

The remarkable uniformity in external characteristics which such asses exhibit has been attributed to the ages of neglect and degradation which they have undergone. The same result has befallen the asses used by the poorer classes in Western India, which are so degraded in size that they are no bigger than a Newfoundland dog. In the continent of Europe, however, and in the East, and even after quite recent artificial selection, external variation is as marked as is observed in many others of our domesti-

cated animals. In Syria alone four breeds are recognized, and if equally careful selection were attended to in more northern countries there is little doubt but that improvement would result.

Only in the southern part of Europe and in certain eastern lands must we look for domesticated asses still characterized by some of the fleetness, nobility of carriage, and fineness of coat of the wild species. In Persia, Arabia, and Egypt much attention is paid to the breeding of an animal possessed not only of great strength, and thus forming an excellent beast of burden, but also suited to desert districts as it requires



FIG. 129. — *Equus asinus*, ass.

comparatively little water, and is able to subsist on dry forage. In northern countries the ass still evinces signs of being originally a desert animal, for it frequently refuses to cross water, and delights in rolling in the dust. Such inherited traits also remind us of the frequent appearance of transverse stripes on the legs, especially of foals, which is unquestionably a "reversion" to the condition typical of the African wild ass.

Even more valuable than the ass, as a beast of burden, and combining its hardiness with the strength of the horse, is the hybrid Mule, which has been known from very early times, and which is of immense service in mountainous districts, such as are met

with in Spain and South America. The cross between a male ass and a mare is called a 'mule;' that between a female ass and a stallion a 'hinny.' Very singular in such hybrids is the prepotency of the ass over the horse: this is especially noticeable in the mule, which invariably resembles the father more than the mother. It is worthy of remark that these hybrids are for the most part sterile: instances of the contrary are recorded, but they are very exceptional. This sterility, however, is by no means incompatible with the vitality of the animal; in fact in sagacity, comparative strength, and sure-footedness the mule appears even to surpass both parents. It requires longer time to attain its full strength than its parents do, but is decidedly longer-lived.

Darwin narrates that the troops of mules in South America are each led by steady old mares, the "madrina" (godmother) carrying a bell. Such is the affection of the mules for their madrina that it is almost impossible to lose them. A mule will carry as much as four hundred pounds on a level road, three hundred in a mountainous district, and the muleteers are so familiar with their animals that they know to a pound how much they can carry, and which may be trusted with the most fragile article.

Three forms of striped horses occur in South Africa, the quagga, Burchell's zebra, and the zebra. The two former are found on the plains, but the latter is entirely confined to mountainous districts. They are occasionally referred to a sub-genus, *Hippotigris*.

The Quagga (*Equus quagga*) stand four feet six inches high at the withers, and measures eight feet six inches in extreme length. The legs are white in color, somewhat robust, but clean and sinewy. The ears and tail are distinctly horse like, the latter white and flowing below the hocks. The upper parts are of a reddish brown hue, which fades off to white below and behind; but the face, neck, and fore parts of the trunk are banded with dark brown stripes, which become fainter and more irregular backwards. A dark line runs along the middle of the back, widening over the crupper. According to Harris:—

"The geographical range of this species of the quagga does not appear to extend to the northward of the river Vaal. The animal was formerly extremely common within the colony, but vanishing before the strides of civilization is now to be found in very limited numbers, and on the borders only. Beyond, on those sultry plains which are completely taken possession of by wild beasts, and may with strict propriety be termed the domain of savage nature, it occurs in interminable herds, and although never intermixing with its own more elegant congeners is almost invariably to be found ranging with the white-tailed gnu, and with the ostrich, for the society of which bird especially it evinces the most singular predilection. Moving slowly across the profile of the ocean-like horizon, uttering a shrill barking neigh, of which its name forms a correct imitation, long files of quaggas continually remind the early traveller of a rival caravan upon its march. Bands of many hundreds are thus seen frequently during their migration from the dreary and desolate plains of some portion of the interior which has formed their secluded abode, seeking for those more luxuriant pastures where, during the summer months, various herbs thrust forth their leaves and flowers to form a green carpet spangled with hues the most brilliant and diversified.

"In its native character the quagga appears to be social and peaceable, living carelessly, sometimes in troops not exceeding twenty or thirty, but oftener in much larger communities. The average standard, both of the males and females, is from twelve to thirteen hands. Doubtless it might readily be subdued by bit and bridle, and if not capable of universal distribution would, in its native regions at least, where food and

climate are congenial, reward fourfold by its services the trouble attendant upon its education. Foals have indeed occasionally been reared when thrown accidentally into the hands of the peasant, but no systematic attempts have yet been made on the part of the indolent colonists to reduce the species to a state of domesticated subjection; and the carnivorous savage tribes occupying the regions which now form its habitat regard it, in common with the rest of the animal creation, only as furnishing them with an ample repast when slain. By the roving clans of Bechuana huntsmen, and the voracious Bushmen hordes, its disgustingly oily, yellow flesh is even esteemed a delicacy; and the lion, which invariably follows the tide of migration towards new pastures,

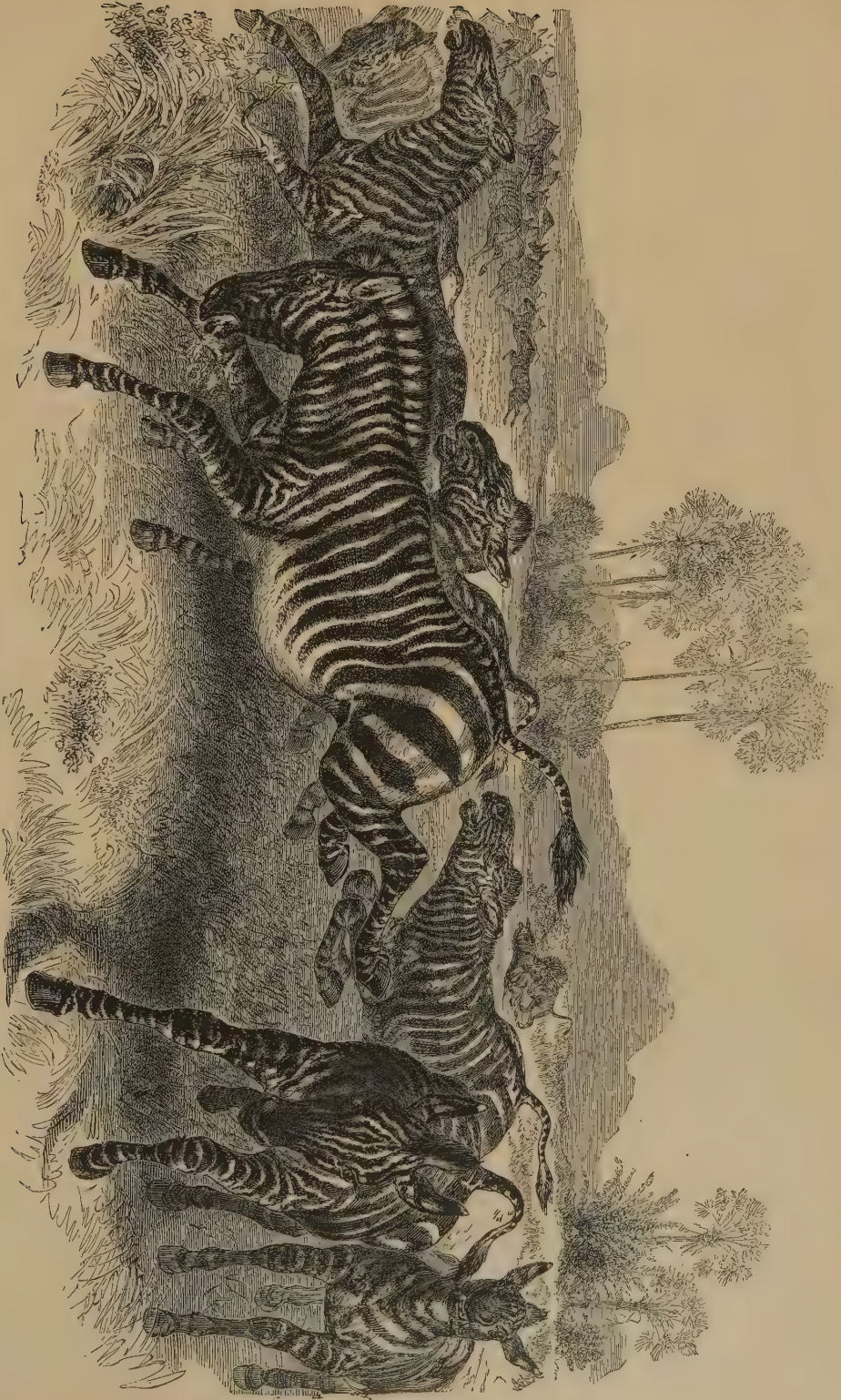


FIG. 129.—*Equus quagga*, quagga.

is not unfrequently driven from his prey at the assegai's point by these two-legged devourers of carrion. The flesh is never used by the colonists except for the purpose of feeding their tame Bushmen, but the hides are valuable for making sacks to contain grain, and the thicker portions which cover the angle of the hocks are greatly esteemed for the manufacture of shoe soles."

Resembling the quagga in general form and size, but approaching more closely to the zebra in coloring, Burchell's Zebra is unquestionably one of the most beautiful of quadrupeds. Its variegated coat has gained for it the name Bonte Quagga from the Dutch colonists; it is the Peetsey of the Matabele and Bechuana, and the *Equus burchellii* of naturalists. It shares with the quagga the equine ears and tail, the latter

Equus montanus, zebra.



being thirty-five inches long, white, and flowing; the belly and legs are also pure white, with the exception of some indistinct transverse bars on the upper part of the latter. Its crest-like mane is striped black and white, contrasting with the brilliant sienna ground color of the head, neck, and body. All of these parts are traversed by black and dark brown bands, which are by no means so regular as those of the zebra, but running in various directions, and forking, give rise to more complicated figures. The bands do not join the median black stripe, which widens slightly over the croup.

The Zebra of modern naturalists, Wilde Paard of the Dutch colonists, and Daow of the Hottentots (*Equus montanus* or *zebra*), is the most handsomely striped of this group of the horses. It is the least horse-like of its immediate allies, for its ears and tail are distinctly asinine and not equine as in the two foregoing forms. It stands four feet high at the withers, and eight feet two inches in extreme length. The body is symmetrical and the legs particularly clean, wiry, and slender. The tail is sixteen inches in length, transversely banded at the root, and tufted with black hair at the extremity. The coat is white, but everywhere, except on the under surface of the belly, marked with glossy black stripes, which run above into the dorsal line, and into the somewhat bushy upright mane. The legs are also striped down to the hoofs both inside and out; the ear is marked with two bay bands, and the face striped with brown. Unlike the two preceding species the zebra has only two instead of four mammae.

As to the habits and occurrence of this species we quote the following from Harris:—
 “Restricted to the mountainous districts of Africa, from Abyssinia to the southernmost portions of the Cape of Good Hope, this beautiful and wary animal never by its own free will descends into the plain, as erroneously asserted by older naturalists, and it therefore never herds with either of its congeners, the quagga and Burchell’s zebra, whose habitat is equally limited to the open and level woodlands. Seeking the wildest and most sequestered spots, the haughty troops are exceedingly difficult of approach as well on account of their watchful habits and extreme agility and fleetness of foot, as from the abrupt and inaccessible nature of their highland abode. Under the special charge of a sentinel, so posted on some adjacent crag as to command a view of every avenue of approach, the chequered herd is to be viewed grazing on the steep hillside, or perambulating some rocky ledge on which the rifle-ball alone can reach them, many a keen-eyed vulture sailing majestically at their feet, over the bosom of the deep blue valley. No sooner has the note of alarm been sounded by the vidette than, pricking their long ears, the whole flock hurry forward to ascertain the nature of the approaching danger, and having gazed for a moment at the advancing hunter, whisking their brindled tails aloft, helter skelter, away they thunder down craggy precipices, and over yawning ravines, where no less agile foot could dare to follow them.

“Although inhabiting the lofty and broken mountain chains to the eastward, that divide Caffraria from the country of the Bechuanas, the zebra occurs in none of the more tropical hills that we visited, and thus proved one of the few game quadrupeds of which no specimen was observed by our party. Small herds still exist within the colonial limits, among the rugged environs of Graaff-Reinet especially, as well as in the mountainous districts of George, which notoriously form one of the chosen cantons of the species; and it was during a visit to the proprietor of a farm in the latter neighborhood that I realized on our homeward journey the gay spoils of the *wilde paard* which now grace my collection of trophies. The capture and sale of the foals forms no inconsiderable addition to Mynheer’s revenues, his numerous sturdy scions devoting a

large portion of their time to the chase of the shy herds—forcing the stragglers occasionally from the mountain fastnesses, and annually disposing of the fruits of their skill with the lasso, for exportation, chiefly to the Mauritius, where they are often whimsically trained to harness.”

SUB-ORDER II. — ARTIODACTYLA.

The even-toed ungulates (Paridigitata) include all cloven-footed quadrupeds, and consequently by far the greater number of our domesticated animals. The toes are generally four or two in number, the first digit being entirely lost in our living forms, and the second and fifth being often quite rudimentary. The essential point about the foot structure is that the axis of the legs being produced passes *between* the third and fourth toes, and not through the third as in the Perissodactyla. The third and fourth toes are thus, taken singly, not symmetrical, while taken together they form a symmetrical pair.

Compared with the Perissodactyla the Artiodactyla have fewer trunk vertebrae, almost always nineteen; the number of those that bear ribs differs much in different forms. The complexity of the stomach, and the smaller length of the cæcum are further points of contrast with the Perissodactyla, which we shall have the opportunity of elucidating further on.

Reference has already been made to the likelihood of the Artiodactyla and Perissodactyla having descended from a common stock, and also to the peculiarities of foot and tooth-structure which living and fossil Artiodactyla exhibit. If before proceeding to discuss the living representatives of this order, we first review the fossil forms from the standpoint indicated, we shall find the crescent-toothed forms greatly predominate in point of numbers over those with tubercular teeth. Of the latter only the pigs and hippopotami survive to represent the extinct *Palæochoerus* and *Choerotherium*, while certain other tubercular-toothed forms in which the foot-structure was reduced on the inadapative plan (*vide* p. 234) have left no successors. Such was the two-toed *Entelodon* of the early miocene period. Again, among the crescent-toothed forms the same phenomenon reappears. The inadapative way of reduction was first adopted and led from four-toed forms like *Bothriodon*, *Dichobune*, and *Hypopotamus* of eocene strata, to the cloven-footed *Anoplotherium*, *Xiphodon*, and *Diplocus* of miocene strata. These, however, left no descendants. They were as richly developed in their characteristic period as the ruminants at the present day, for some small forms of *Hypopotamus* are known as small as a rabbit, others, like *Anthracotherium*, as large as a hippopotamus; but they were superseded in the struggle for existence by the descendants of some forms which separated from the main stock at the early part of the eocene period, and which, following the adaptive plan of reduction of the foot, in virtue of which the toes gradually gained a footing on the whole surface of the wrist and ankle-joint, gave rise to the crescent-toothed forms of the present day. The intermediate stages are little known, but the camels were probably descended from *Poebrotherium*, the chevrotains from an extinct form resembling *Hyomoschus*, and the ruminants proper from some form like *Gelocus*.

The Artiodactyla are usually sub-divided into the non-ruminating and the ruminating forms. In speaking of the fossil species, this grouping answers to the two lines of development indicated above, for the non-ruminating forms are typically tubercular-toothed, the ruminating crescent-toothed in accordance with their omnivorous and

herbivorous habits respectively. Both in respect to the teeth and the toes the non-ruminating forms are less modified from the primitive artiodactyle type, for as we shall see there is a tendency among the ruminants to the reduction of both of these organs in number. We shall therefore describe the non-ruminating forms in the first place. They constitute the first of the super-families, and include the pigs and the hippopotami.

SUPER-FAMILY I. — SUINA.

The skin in this group is either hairless or beset with bristles. Horns are never present, but, as is the case even among ruminants occasionally, their absence is frequently compensated by great tusk-like canine or incisor teeth. The stomach is compound, but the groove which renders possible the return of the food to the mouth for the chewing of the cud is absent. The placenta is diffuse in all.

The pigs and their allies have been called *Setigera*, as the skin is more or less thickly beset with bristles. The term *SUIDÆ* is, however, preferable for the family.

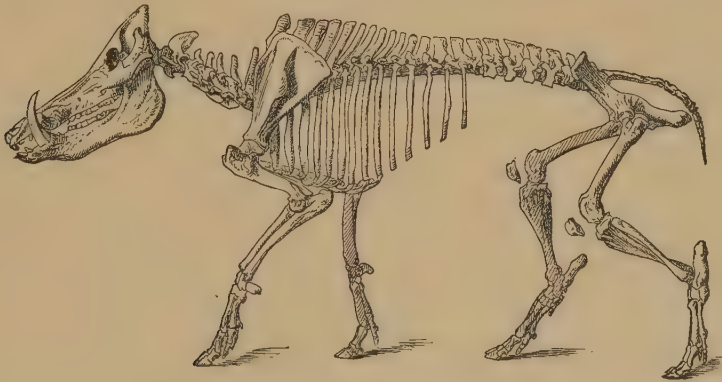


FIG. 130. — Skeleton of wild boar, *Sus scrofa*.

The head is prolonged into a snout, which is pointed or truncated; the body is smaller and less clumsy than in the next family, and its weight is carried on the third and fourth toes, while the second and fifth are shortened into after-claws, and do not touch the ground although all their bones are present. In the peccary the fifth is more rudimentary than in the pig.

A further peculiarity which marks out the *Suidæ* of the new world from those of the old is the difference in the number of young. There are eight or ten teats and large litters in the one group, but only two teats, and, as a rule, one young in the peccaries. Six genera have been distinguished in this family. Some of those which are most closely related to the pig are certainly not so distinct as the peccary, but the employment of the separate generic names will facilitate the description of the various forms. The domesticated hogs and a number of wild animals scattered over Europe, Asia, and the Malay Islands, belong to the genus *Sus*. In all of these the ears are ovate and hairy, the tail moderate in length and tufted at the extremity. The face and snout are of conical form and are destitute of the protuberances found in some other genera, although one or two species (*S. verrucosus*) have warts upon the cheeks. The canines of the boar are well-developed, and are recurved in the upper

jaw. Such are the diagnostic features of the genus *Sus*; a short reference to other points of anatomical interest may precede our description of the various species. Although it has been stated above that nineteen is the typical number of trunk vertebræ for the Artiodactyla, some species and domesticated forms may depart from this rule, and have as many as twenty-two. Such an extensive variation in this region of the skeleton is rarely met with in nearly related forms. The caudal vertebræ are less constant, being from twenty to twenty-three, a large number in comparison with the six or nine joints of the almost tailless peccaries.

The muscles of the neck, in accordance with the habits of the animal, are extremely powerful, a condition which contributes to the formation of a very prominent transverse crest on the occipital bone. In the snout are two extra ossifications between the premaxillaries and nasal, the so-called prenasal; these aid in strengthening the cartilaginous plate which terminates the snout.

The milk teeth are complete when the pig is three months old, and are arranged according to formula *i.* $\frac{3}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{4}{4}$; the first of the grinders is not replaced, so the adult dentition is *i.* $\frac{3}{3}$, *c.* $\frac{1}{1}$, *pm.* $\frac{3}{3}$, *m.* $\frac{3}{3}$. The incisors are small, the canines large, prismatic, the fore surface of the upper ones and the hind surface of the lower ones working against each other. As these teeth are subjected to much use, especially in the wild boars, their roots do not close for a long time. The premolar teeth do not bear tubercles like the grinders proper, but have a single longitudinal cutting ridge; and the stomach, formed of a single compartment, exhibits certain indications of the subdivisions which characterize the babirusa and the peccaries.

Our domesticated swine (*Sus scrofa domesticus*), like so many of the domesticated animals, do not form any distinct zoological species, but a series of races or breeds which contain the blood of, at any rate, two distinct wild species, — *Sus scrofa*, the Wild Boar of Europe, and *Sus indicus*, the progenitor of the Chinese domesticated swine. Some breeds appear to have more of the one element than the other thus the Turkish pigs have curly hair and striped young like the more western species, while the tendency in Europe and America has been towards the infusion of more and more of the blood of the eastern species by frequent crossings with the 'Siamese breeds.'

The European wild boar is now confined to the less populous and more wooded parts of eastern Europe, and is preserved in certain forests for purposes of sport. It is entirely extinct in England, but probably extends throughout all eastern Europe into Asia Minor, the wild boars met with there being at any rate closely allied to the European species. In size the wild animal considerably exceeds the hog; the legs are longer and more muscular, and the back therefore much higher. The face is also more elongated, and the tusks better developed. In color dusky brown hues with black spots and streaks prevail; the bristles of the coat are stronger and more abundant than in the hog; being especially long and strong along the dorsal line and erectile at the will of the animal. Between the bristles is an abundant crop of fine woolly hair, which forms a curly coat for the animal.

The wild swine are not gregarious in their habits, but the males live a solitary life, only associating with the females at pairing time. They seek out moist and shady places in the forest where they spend the day, emerging at night to look for the herbs, roots, grubs, etc., on which they feed. In their search for roots the nerves, which supply the naked snout and their delicate sense of smell, are of assistance to them, so that underground fungi, like truffles, are readily detected. Their tusks are of service in digging up the roots on which they feed, and near their haunts hunters recognize

the traces of their presence by the scored appearance of the ground. The tusks are also their weapon of offence and defence; although wild swine will rarely attack man of their own accord, yet at certain seasons, and in the case of the females in defence of the young, they have been known to take the initiative. When pursued and brought to bay the boars use their tusks with great address; these are turned upward in such a manner that their stroke is delivered from below, and when that is possible boars may prove formidable antagonists to dogs and horses. The solitary males acquire a morose disposition with age, and therefore old animals with their increased fierceness furnish the best sport. Unlike the domesticated animals the wild swine are exceedingly swift, a good horse being necessary to overtake them when in full gallop. In Europe they are generally driven or hunted with dogs, although the large boar-hounds that were once reserved for their chase are almost an extinct breed. The rutting season is in the end of the year. The sow goes with young for four months, after which she conceals herself and her litter from the vicious male. Even after the litter of swine are weaned the mother keeps them with her and protects them with the utmost care, going out of her way occasionally to attack chance passers-by whom she suspects of evil intent. The young are distinctly striped, a phenomenon which, in the light of similar facts, is interpreted as evidence of descent from a striped ancestor. It is interesting to note with what persistence this phenomenon recurs among the Ungulata generally.

The flesh of the wild boar is considered to be superior in some respects to that of the hog, gaining in 'gaminess' what it loses in fat; during the rutting season it is, however, too rank to be edible. The wild pigs of Hindostan, which afford to the British resident the amusement of 'pig-sticking,' belong to the species *S. cristatus*, closely allied to the European wild boar. The specific name refers to the well-marked mane of bristles along the dorsal line. The general color is yellowish brown, but the cheeks have a white beard. These pigs live in the impenetrable jungle, which they leave only when seeking food in the plantations, or when driven by natives or jungle fires into the open fields. They are pursued on horseback, the rider forcing up his horse to the side of the boar, and delivering a spear, after the manner of driving a javelin, into his flanks. Like the European wild animal the Indian boar is extremely courageous and a very formidable enemy.

From the islands of the Malay Archipelago five or six distinct species of swine have been described. Such are the *S. verrucosus* and *vittatus* of Java, *celebensis* of Celebes, *barbatus* of Borneo, and others. It is probable that many of these are merely local varieties, modified by the peculiar conditions of the islands on which they are found. These have probably been peopled from the mainland, because we know that pigs take readily to water and swim well, a fact which explains their presence on some of these islands of the Malay Archipelago, where no other ungulate occurs. Australia, alone, is not inhabited by any member of the group in a wild state.

S. vittatus, of Java, and *S. leucomystax*, of Japan, are the wild forms most nearly allied to the *S. indicus* from which all the eastern domesticated breeds are supposed to have been derived. Some authorities consider that this species had a wider distribution than at the present day, not being confined to Asia but extending into Europe. It is to the admixture of the blood of the Eastern breeds that the best bred hogs owe the extreme shortness of the skull, for the northern European breeds which come most closely to the wild boar are all marked by the length of the head and the legs. The Chinese have had the pig under domestication for thousands of years, and it is no

doubt due to this circumstance that so great improvements have been effected in the breeds of other countries by crossing with the eastern animals.

One of the most curious forms of domesticated pigs is that which is known as the Japanese Masked Pig; although it is looked on by many naturalists as merely a variety of the common Chinese species, others regard it as distinct (*S. pliciceps*), and the separate genus *Centuriosus* has even been established for it. It is of blackish gray color, white on the under parts, but is chiefly remarkable for the regular, deep furrows on the face, and the large, rounded, pendulous ears, as well as for the thick fold of hard skin which hangs about the shoulders and rump. Its young are not striped, a sufficient indication that it has long been domesticated.

Domestication has brought about certain very important changes in the hog. No longer dependent on the senses to apprise it of danger, its ears become much

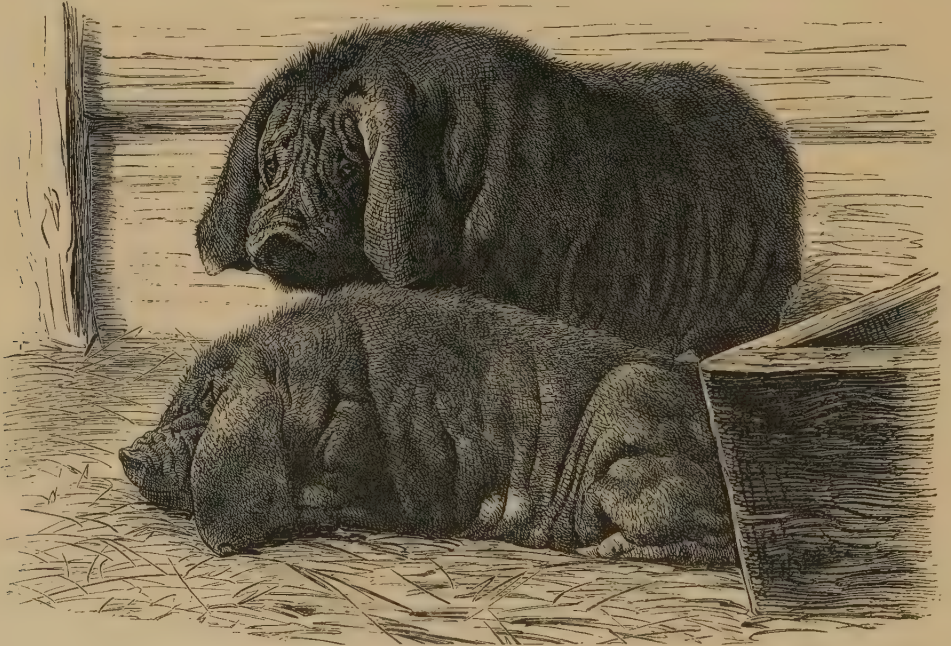


FIG. 131. — *Sus pliciceps*, masked pig.

smaller and less movable. The organs of defence are not required, for the natural courage of the wild animal has almost entirely disappeared; so we find the tusks much diminished in size. This change is of course partly attributable to the difference in nature of the food and the ease with which it is obtained, a difference which also accounts for the greater length of the intestinal canal. The shape of the body is likewise altered; the trunk becomes longer, the legs shorter and less muscular, but the insatiable appetite remains, so the excess of food is deposited in thicker layers of fat beneath the skin than are found in the wild animal, and the litters of the female are larger and more frequent. The habits, also, undergo alteration, for instead of searching for food at night and resting in solitary lairs during the day, the domesticated hogs have become diurnal and gregarious animals.

It is hardly necessary to do more than refer to the uses of the hog. The readiness with which the fat imbibes salt renders it the most easy flesh to preserve in a pickled

condition, and consequently at sea and in thinly settled countries pork is one of the necessities of life. The hide and the bristles are also of great economic importance.

Hogs which have been turned into the woods acquire some of the characteristics of the wild animal. Their coats are more hairy, their legs more powerful, and they do not become so fat. It has been noticed that the male does not re-acquire the solitary habits which characterize the wild boar, but associates with the rest of the herd. Judge Caton remarks that the hogs which have become feral in the Hawaiian Islands have in many cases regained the coloring and shape of the wild animal, stripes being readily distinguished on the young, and the back is more arched.

A curious anomaly of the foot structure of the pig has been frequently recorded from the time of Aristotle downwards, which consists in the coalescence of the last joint and the hoofs of the middle toes, a single solid hoof resulting. Such 'solid-hoofed pigs' breed singularly true. Dr. Coues met with a breed in Texas which exemplified this in a marked degree, so much so as to indicate that it would not be difficult to form a race of solid-hoofed pigs, just as we have races of the domestic fowl with deformed skulls.

The genus *Porcula* embraces certain oriental hogs of pigmy dimensions. One of them is the *P. papuensis* of New Guinea, the only hoofed animal of that island, so singular in its fauna. It is distinguished by the possession of a short black mane along the dorsal line from *Porcula salvania*, a native of the Terai, in India, a full-grown specimen of which measures nineteen inches in length, its tail hardly two inches, while it weighs only from eight to ten pounds. They live in large herds of five hundred or so, in the jungle, and feed on bulbs and roots. They are extremely shy, but as their flesh is esteemed a great delicacy they are trapped in nets and hunted with dogs by the natives. A litter of three or four young is cast after a gestation of between five and six months. The incisors are rudimentary, the canines are small but project from the mouth to a certain extent. The fourth toe on all the feet is smaller than the others, a foreshadowing of its loss in the peccary.

The third genus, *Potamochoerus*, includes two pigs of somewhat more graceful proportions, and decidedly richer in coloring than any of the members of the preceding genus. They are inhabitants of the south and west of Africa, and are known as the South African wild boar (Bosch Vark of the Dutch), and the Red River hog, or painted pig of the Guinea coast respectively. Both are characterized by the elongation of the head, by the long ears, which suddenly taper and end in a pencil of hairs, and by the long tail, the root of which is high up on the rump, and its tip also pencilled. The canines are of large size, and the sockets for those of the upper jaw form a protuberance on each side of that bone. There are only six, instead of seven grinders on each side in each jaw, and half-way between the eyes and the end of the snout are two warty swellings, which rest on rough projections from the underlying bone.

The Bosch Vark is very variable in coloring; some are black variegated with yellowish white, others reddish brown without the yellowish tints. The ears are densely haired, white internally but with a black edge and tuft. The painted pig, on the other hand, has the edges of the ears and the tuft white. The coat, the hairs of which are longest on the lower parts of the flanks, is reddish-brown on the upper parts, and grayish-white below. The head and ears, however, are black, with the exception of a ring of longer white hairs round the eyes, and whiskers of the same color. The hair along the whole middle line of the back is elevated into a short mane, which is also white in color. This species was introduced by negroes into Brazil, but appears

to occur there no longer. A third, less known species is the *P. edwardsii*, from Madagascar. Unlike the species of *Sus* only four young are found in a litter, and the teats of the sow are similarly reduced in number.

The fourth genus, *Porcus*, embraces the singular Babirusa of Bourroo and Celebes. This form has already lost one of the pairs of upper incisor teeth, which are present in the Hog, and has, further, only five grinders in each jaw. The following description of this species is from Wallace's "Malay Archipelago."

"The wild pig seems to be of a species peculiar to the island, but a much more curious animal of this family is the babirusa or pig-deer, so named by the Malays from its long slender legs, and curved tusks resembling horns. This extraordinary creature resembles a pig in general appearance, but it does not dig with its snout, as it feeds on fallen fruits. The tusks of the lower jaw are very long and sharp, but the upper ones,



FIG. 132. — *Porcus babirusa*, babirusa.

instead of growing downward in the usual way, are completely reversed, growing upwards out of long sockets through the skin on each side of the snout, curving backwards to near the eyes, and in old animals often reaching eight or ten inches in length. It is difficult to understand what can be the use of these extraordinary horn-like teeth. Some of the old writers supposed that they served as hooks by which the creature could rest its head on a branch. But the way in which they usually diverge just over and in front of the eye has suggested the more probable idea that they serve to guard these organs from thorns and spines while hunting for fallen fruits among the tangled thickets of rattan and other spiny plants. Even this is not satisfactory, for the female, who must seek her food in the same way, does not possess them. I should be inclined to believe rather that these tusks were once useful, and were then worn down as fast as they grew; but that changed conditions of life have rendered them unnecessary, and they now develop into a monstrous form, just as the incisors of the beaver or rabbit will go on growing, if the opposite teeth do not wear them away.

"Here also we have a resemblance to the wart-hogs of Africa, whose upper canines grow outward and curve up so as to form a transition from the usual mode of growth to that of the babirusa. It is found all over Celebes, and in the Sulu islands, and also in Bouroo, the only spot beyond the Celebes group to which it extends, and which island also shows some affinity to the Sulu islands in its birds, indicating, perhaps, a closer connection between them at some former period than now exists. At this time the babirusa may have entered Bouroo, since it probably survives as well as its allies the pigs. These are spread all over the Archipelago, even to several of the smaller islands, and in many cases the species are peculiar. It is evident, therefore, that they have some natural means of dispersal."

The peccaries (*Dicotyles*) constitute an interesting division of this family, and might even be separated under a distinct subfamily, so peculiar are they in many respects. One pair of the upper incisors has disappeared, so that the dental formula is $i. \frac{2}{3}, c. \frac{1}{1}, m. \frac{4}{4}$.

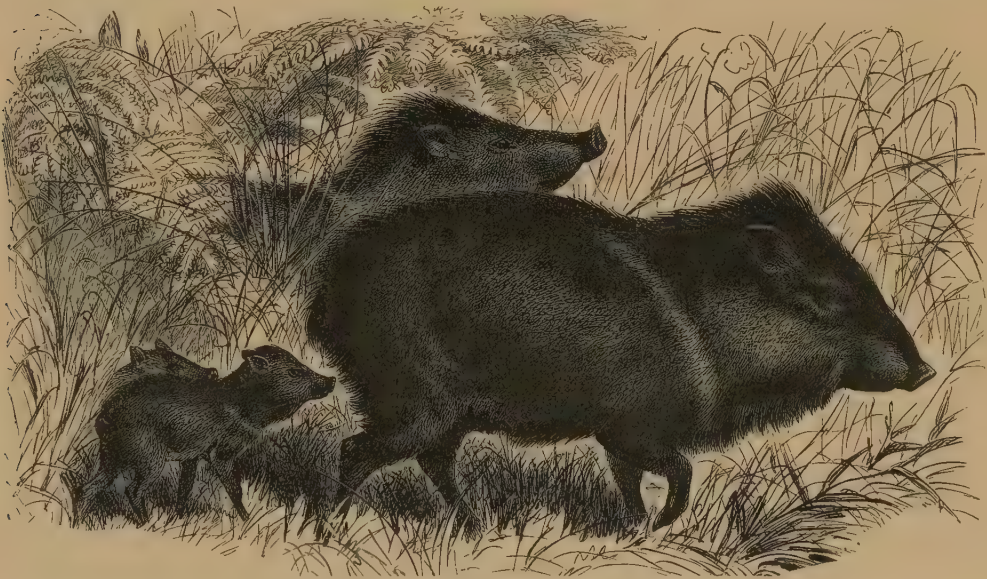


FIG. 133.—*Dicotyles torquatus*, collared peccary.

The teeth are much less tubercular than in the pig, the stomach is divided into three compartments, with a groove leading from the gullet direct towards the pyloric end, the metapodials of the third and fourth toes are coalesced into a cannon bone, and the outer toe of the foot is reduced to a splint bone, all peculiarities leading directly to the modifications which we regard as distinctly ruminant. The peccaries thus constitute the most specialized group of non-ruminating artiodactyles.

The peccaries do not cross with the hog, and very rarely breed in confinement. The Texan species, *D. torquatus*, is found throughout Mexico and as far north as the Red River of Arkansas, but the northern parts of South America must be regarded as the headquarters of this as well as the other species. It is abundant along the Rio Grande, where it is found along the water courses, generally singly but often in herds on the prairies. They are said to be ferocious when wounded, and when one of their number has been struck the remainder of the herd will take the offensive. The flesh is almost inedible, owing to a cutaneous gland opening on the rump, the secretion of

which is hardly less offensive than that of the skunk. The aperture of this gland is on the dorsal line opposite the navel, to which circumstance the genus owes its Linnæan name *Dicotyles*. They are very shy in open ground, and when pursued immediately make for thickets, from which it is very difficult to drive them. Their food in Texas consists of acorns and pecan nuts, but in South America it is said to be by no means exclusively a vegetable-feeder. Unlike hogs they do not take to pools except in the very hottest weather, even then they do not wallow in the way characteristic of all species of pigs. The skin is much more thickly beset with bristles than in the pig generally; these are particularly long on the back of the head, the nape of the neck,



FIG. 134. — *Phacochoerus aethiopicus*, wart hog.

and the throat. The general color is dark brown mixed with yellowish, but an oblique white stripe on the neck and shoulders characterizes this species from the next, whence the name of Collared Peccary sometimes given to it. The peccary is little over three feet long, and sixteen inches high; the legs are short and slender, and the tail quite rudimentary, containing only six vertebræ. The female only casts a single or, at most, two young, and in accordance with this the teats are only two in number.

The second species, *D. labiatus*, is some six inches longer and proportionately higher; the tail is also somewhat longer, being composed of nine joints. The shoulder-stripe of the preceding species is absent, but the lower jaw is colored white and the rest of the coat grayish black. The White-Lipped Peccary lives gregariously in the forests of Guiana, Brazil, Paraguay, and Peru, and frequently does immense

damage to the plantations, invading them as it does in very large hordes. In many of their habits they resemble their northern congeners, but defend themselves when attacked with greater vigor than these. Their nocturnal habits render them somewhat difficult of pursuit, but the aborigines shoot or spear them from trees, where they are safe from the attacks of the rest of the herd. A sentinel leads the whole herd, which becomes totally disorganized should their leader fall. Water presents no obstacle to the peccaries, for they swim as well as the wild boar, and indicate their love for it further by bathing in muddy pools. The flesh of the white-lipped peccary is not so strong-tasted as to be offensive to the Indians, but it is not appreciated by the white inhabitants.

The last genus of this family (*Phacochoerus*) embraces the African Wart-Hogs, the most unsightly members of the group. The reduction in the number of teeth has gone on to a very remarkable extent, so that in the adult the incisors are only one pair in the upper jaw, although there are still the customary three pairs in the lower. The canines are enormously developed, and serve for rooting up the favorite food of the creature. Both pairs curve upwards. Although five grinders appear in the mouth, only the hindmost, with a mere remnant of the one in front, are found in the old animal. These solitary molars are of great size, grow for a long time before the roots eventually close, and bear, on the masticating surface from six to fourteen pairs of tubercles, which get worn down into little islands of enamel. Owen observes that the monopolizing of the masticatory process by one tooth in each jaw throws a great deal of light on the still more abnormal dentition of the elephant.

The commonest species from South Africa, *P. aethiopicus*, measures about two feet six inches at the shoulder. Its skin is reddish brown in color, and very scantily beset with bristles. The top of the head and the dorsal line along the back are, however, armed with long rigid bristles which form a sort of dorsal mane. Under the enormous canines are long white whiskers. The common name is derived from the remarkable fleshy warts which are situated behind each eye and behind the tusks. The ears are bordered with strong hair, the eyes placed high in the head, with black lashes and long brows. The tail, twenty inches long, straight and thin like the lash of a whip, is tufted with bristles. Unlike the last genus all the feet are four-toed, the side hoofs are small and loose, and the fore-feet have a callous pad.

A second species, *P. aliani*, is found on the coast district of the Red Sea. Its sides are more scantily haired than those of its southern ally, but the bristles on the back and nape, and the whiskers are much longer.

In certain respects the second family, HIPPOPOTAMIDÆ (or Obesa), must be regarded as more specialized than the Suidæ, whereas in others they exhibit more generalized features. The skin is extremely thick (almost two inches); they therefore well deserve to be classed with the Pachydermata of the older zoologists. The family name Obesa embodies the ungainliness of the huge trunk and head, while the generic name, *Hippopotamus*, recalls the fact that this is one of the most amphibious of ungulates. Only two species are known, one of large size, *H. amphibius*, common throughout the greater part of Africa, in which the body may be fourteen feet long and the head three, and a small species occurring on rivers of the west coast and those flowing into Lake Tschad, *H. liberiensis*, which differs in so many important points from the eastern form that Professor Leidy formed the genus *Choeropsis* for its reception.

The legs have four toes, all of which touch the ground, a more primitive condition than is found in the swine, while the teeth exhibit fewer incisors, and a molar pattern which points to the grass-eating habits of the animal, as does its complex stomach. In these points we observe something of the same sort of specialization which has led to the development of the ruminants from earlier tubercular-toothed Artiodactyla. The incisors, four in number in each jaw, are short, straight tusks, separated by a



FIG. 135. — *Hippopotamus amphibius*, hippopotamus.

median interval, while the canines are enormously developed, and are curved in such a way that the upper ones fit inside the lower, the contiguous surfaces being gradually worn flat. These tusks, the lower ones especially, may occasionally attain a very large size; one has been measured thirty inches on the curve, with a circumference of nine inches, and a weight of seventeen and one-half pounds. Their ivory is valuable, for, not being liable to discoloration, it is occasionally employed by dentists for making artificial teeth. The tusks leave their trace in the rank herbage by the river banks, the

ground in many places looking as if gone over with a harrow: they are also employed for tearing up aquatic weeds, on which the animals largely depend for food.

The liquid constituents of the food pass, according to Dr. Chapman, directly into the second and third compartments of the four-divided stomach, while solid food remains for some time in the first portion. The comparison of the simple stomach of the pig with the more complex organs of the peccary and hippopotamus is extremely interesting, showing as it does how the typical form of the organ in the ruminants, which we shall describe further on, has been evolved.

The amphibious life has necessarily reacted on certain of the organs of the body. Thus the nostrils are extremely flexible, and may be tightly closed by muscular exertion when the animal is under water. Very often the hippopotamus is seen with nothing but the nostrils above the water, and then a direct passage of the air into the lungs is secured by the high larynx, which may be fitted up into the posterior nostrils in such a way as to prevent water getting into the respiratory passages. Dr. Chapman remarks that the blood is extremely rich in colored disks, of small size, and as these serve to distribute oxygen to the tissues, it is not improbable that their exceptional number renders it possible for the animal to remain under water as long as it does.

The males are the most formidable to meet with; the females, on the other hand, are of more amiable temperament, except when they have a calf to defend. They are most affectionate mothers. Bartlett records, that in the zoological gardens a calf was born which in half an hour was able to stagger about, followed and licked by the mother. The period of gestation is between seven and eight months.

One of the most singular peculiarities of the hippopotamus is the nature of the secretion of the sweat-glands, which has gained it the name of the "blood-sweating beehemoth," and which gives to the animal the reddish color which it has on first emerging from the water. There is no doubt that the color is due to the presence of blood cells, but it is difficult to interpret their presence to such an extent in the perspiration.

Schweinfurth, in his "Heart of Africa," gives the following account of his observations on the hippopotamus: "The color of nearly all these animals was a dark, fleshy red, almost like raw meat, marked irregularly with large black spots. I also saw specimens of a lighter shade, but never of a pure white. In the sunshine their damp bodies assumed quite a bluish-gray hue. Half of the hippopotamuses that I noticed at this deep part of the river, which extended for about a mile, were females carrying their young, which at this season seemed very weak or undeveloped, and sat astride on the short necks of their mothers. The females appeared to rise to the surface of the water for the sake of their young, far more frequently than was necessary for their own accommodation, and unlike the males, which usually show their mouth and nostrils, they only lifted their young above the water, whilst their own heads generally remained invisible. The animals seem to utter different sounds at different seasons; they now snorted and grunted, or, rather, groaned, and the sharp rattling gurgle was less distinct than in the spring. In the sunlight the fine spray emitted from their nostrils gleamed like a ray of light. Now and then, with a frightful roar that resounded far away, the males would leap violently from the water, displaying all the fore part of their huge bodies. They seemed to be scuffling together, but whether they were quarrelling for a monopoly of the limited space, or whether they had been hit by some of my bullets, I could not determine. Their small, pointed ears were remarkably flexible, and were continually moving to and fro as the animals listened to distant sounds or flapped away the settling insects.

"We were hard at work the following day in turning the huge carcass of the hippopotamus to account for our domestic use. My people boiled down great flasks of the fat which they took from the layers between the ribs, but what the entire produce of grease would have been I was unable to determine, as hundreds of natives had already cut off and appropriated pieces of the flesh. When boiled, hippopotamus fat is very similar to pork-lard, though in the warm climate of central Africa it never attains a consistency firmer than that of oil. Of all animal fats it appears to be the purest, and at any rate never becomes rancid, and will keep for many years without requiring any special process of clarifying. It has, however, a slight flavor of train-oil, to which it is difficult for a European to become accustomed. It is stated in some books that hippopotamus bacon is quite a delicacy, but I can by no means concur in the opinion. I always found it unfit for eating, and when cut into narrow strips and roasted it was as hard and tough as so much rope. The same may be said of the tongue, which I often had smoked and salted. The meat is remarkably fibrous, and is one continuous tissue of sinews.

The hippopotamus is hunted in different ways in different parts of Africa. That pursued on the river Zambesi and its tributaries is graphically described by Holub in his "Seven Years in South Africa."

"After re-embarking we kept close to the shore with the object of avoiding the hippopotamuses that in the daytime frequent the middle of the stream, only rising from time to time to breathe. Whenever the current made it necessary for us to change to the opposite side of the river I could see that the boatmen were all on the *qui vive* to get across as rapidly as possible, and I soon afterwards learned by experience what good reason they had to be cautious. We had occasion to steer outward so as to clear a papyrus island, when all at once the men began to back water, and the one nearest me whispered the word 'kub:.' He was pointing to a spot hardly two hundred yards ahead, and then a second, raised above the surface of the stream, both puffing out little fountains from the nostrils. They quickly disappeared, and the men paddled on gently till they were tolerably close to the place where the brutes had been seen. Both Blackley and I cocked our guns, and had not long to wait before the heads of two young hippopotamuses emerged from beneath the water, followed first by the head of a male and then by a female. We fired eight shots, of which there was no doubt that two struck the old male behind the ears. The men all maintained that it was mortally wounded, and probably such was the case; but although we waited about for nearly an hour we never saw more than the heads of the three others again. It was only with reluctance that the men were induced to be stationary so long; except they are in very small boats and properly armed with assegais they are always anxious to give the hippopotamus as wide a berth as they can. Of all the larger Mammalia of South Africa I am disposed to think that to an unarmed man the hippopotamus is the most dangerous. In its normal state it can never endure the sight of anything to which it is unaccustomed or which takes it by surprise. Let it come upon a horse, an ox, a porcupine, a log of wood, or even a fluttering garment suddenly crossing its path, and it will fly upon any of them with relentless fury; but let such object be withdrawn betimes from view and the brute in an instant will forget all about it and go on its way entirely undisturbed. Although in some cases it may happen that an unprotected man may elude the attacks of a lion, a buffalo, or a leopard, except they have been provoked, he cannot indulge the hope of escaping the violence of a hippopotamus that has once got him within reach of its power. When, out of several hippopotamuses in a river, one

has been wounded, the rest are far more wary in coming to the surface, and should the wound have been fatal the carcass does not rise for an hour, but drifts down the stream. The Marutse have a very simple but effectual way of landing their dead bodies. A grass rope with a stone attached is thrown across it, and by this means it is easily guided to the shore. The whole riverside population is most enthusiastic in its love of hippopotamus-hunting, and it is owing to the skill of the Marutse natives in this pursuit that they have been brought from their homes in the upper Zambesi and established in villages down here, where they may help to keep the court well supplied not only with fresh and dried fish, but particularly with hippopotamus flesh. The boats that are used as 'mokoro tahi kubu' (hippopotamus canoes) are of the smallest size, only just large enough for one; they are difficult to manage, but are very swift; the weapons employed are long, barbed assegais, of which the shafts are so light that they are not heavier than the ordinary short javelins for military use.

"Although I have often tasted hippopotamus meat I cannot say I like it. The gelatinous skin when roasted is considered a delicacy; in its raw state it makes excellent handles for knives and workmen's tools, as it shrinks as it dries, and takes firm hold upon the metal. If a hippopotamus is killed within fifty miles of Sesheke half of it is always sent to the king, and the breast reserved for the royal table. It is at night time that the hippopotamus generally goes to its pasturage, in the choice of which it is very particular, sometimes making its way eight or nine miles along the river bank, and returning at daybreak to its resort in the river or lagoon, where its presence is revealed by its splashes and snorts. Occasionally it is found asleep in the forests ten miles or more away from the water. In eastern and southern Matabele land, and in the Mashona country, where they are found in the affluents of the Limpopo and the Zambesi, it is a much less difficult matter to capture them, and Matabele traders have told me that they have seen Mashonas attack them in the water with broad-bladed daggers, and soon overpower them.

"In time past hippopotamuses were common throughout South Africa, and the carvings of the bushmen would go to prove that they not only frequented the rivers, but found their way to the salt rain-pans; they are still to be found in the rivers of Natal, and I was told in Cape Colony that they are in existence in Kaffraria; but in central South Africa they are not seen south of the Limpopo."

The method of hunting employed by the Arabs in the Soudan is somewhat different from the above. Sir S. Baker says that the natives will swim into a river for the purpose of harpooning the hippopotami; the barbs enter the hide some two or three inches, and although the huge creature plunges off on feeling the wound, a float attached to the harpoon indicates his whereabouts. The animal is afterwards secured by ropes in a manner which may be best described in Sir S. Baker's own words.

"Two men swam across with one end of the long rope. Upon gaining the opposite bank I observed that a second rope was made fast to the middle of the main line, thus upon our side we held the ends of two ropes, while on the opposite side they had only one; accordingly the point of junction of the two ropes in the centre formed an acute angle. The object of this was soon practically explained. Two men upon our side now each held a rope, and one of these walked about ten yards before the other. Upon both sides of the river the people now advanced, dragging the rope on the surface of the water until they reached the ambatch float that was swimming to and fro, according to the movements of the hippo below. By a dexterous jerk of the main line the float was now placed between the two ropes, and it was immediately secured

in the acute angle by bringing together the end of these ropes on our side. The men on the opposite bank now dropped their line, and our men now hauled in upon the ambatch float that was held fast between the ropes. Thus cleverly made sure, we quickly brought a chain upon the hippo, and although I have had some experience in handling big fish I never knew one to pull so lustily as the amphibious animal that we now alternately coaxed and bullied. He sprang out of the water, gnashed his huge jaws, snorted with tremendous rage, and lashed the river into foam. He then dived and foolishly approached us beneath the water. We quickly gathered in the slack line, and took a round turn upon a large rock within a few feet of the river. The hippo now rose to the surface about ten yards from the hunters, and jumping half out of the water he snapped his great jaws together endeavoring to catch the rope, but at the same instant two harpoons were launched into his side. Disdaining retreat, and maddened with rage, the furious animal charged from the depths of the river, and gaining a footing, he reared his bulky form from the surface, came boldly upon the sandbank, and attacked the hunters open-mouthed. They were not the men to fear a pair of gaping jaws, armed with a deadly array of tusks, but half a dozen lances were hurled at him, some entering his mouth, from a distance of five or six paces, at the same time several men threw handfuls of sand into his enormous eyes. This baffled him more than the lances; he crunched their shafts between his powerful jaws like straws, but he was beaten by the sand, and, shaking his huge head, he retreated to the river. During his sally upon the shore two of the hunters had secured the ropes of the harpoons that had been fastened in his body just before his charge. He was now fixed by three of these deadly instruments; but suddenly the ropes gave way, having been bitten through by the enraged beast who was still beneath the water. Immediately after this he appeared on the surface, and without a moment's hesitation he once more charged furiously from the water straight at the hunters, with his huge mouth open to such an extent that he could have accommodated two inside passengers. Again they tried to lance him, and threw sand in his face, etc. The fight had continued for three hours, and the sun was about to set. Accordingly the hunters begged me to give him the *coup de grâce*, as they had hauled him close to the shore, and they feared he would sever the rope with his teeth. I waited a good opportunity and shot him dead between the eyes."

GROUP RUMINANTIA, OR PECORA.

In giving a general account of the principal anatomical features of the ruminating animals we shall confine ourselves to the typical forms, such as the deer, oxen, antelopes, sheep, and goats, leaving for subsequent reference the camels and chevrotains, which depart in important respects from the types named.

The skin varies in thickness, but never approaches that of the hippopotamus. It is clothed with hair, which may be short and lie close to the skin, or may form a more or less woolly covering. There is generally an admixture of wool with the larger and coarser hair, and in climates where there is a much lower winter temperature the winter coat may differ very materially both in color and amount from the summer coat. The shedding of the hair in the spring is thus an important physiological fact to be attended to in these animals, attended, as it often is, with the shedding of the horns. The end of the snout (muzzle or muffle) may be naked, and the shape of this bare spot round the nostrils (rhinarium) is often of importance to the systematist.

Almost all ruminants have a symmetrical pair of horns. If these are absent their place is taken by enlarged canine teeth, which, like the horns, are either absent or of less size in the females. The horns are either hollow, with a bony core, as in the oxen, antelopes, and sheep, very often present in both sexes, and persistent throughout life, or else, as in the deer, they are solid and often much branched outgrowths of the frontal bones, which are renewed every year, are present, with rare exceptions, only in the males, and are only covered with soft skin during a short period of the year.

Of great importance, from a physiological and also from a systematic point of view, are certain glandular portions of the skin. These are found at certain parts of the body, but a very common position is on the face, below the eye, whence such glands are named sub-orbital. The terms *crumen* and *larmier* are also applied to these structures. They appear to be developed in connection with the sexual function, to enable animals of the same species to find each other at pairing time, and we accordingly find that they are rare in gregarious forms. Other glands which subserve the same purpose will be referred to in the course of our description of the musk deer, pronghorn, etc. Between the toes are certain glands which probably serve to pour out a lubricating secretion into the cleft of the foot; these are the interdigital glands, and their presence or absence is frequently used as a character of importance by the systematist.

The most striking osteological peculiarity is the reduction in number of the toes; the second and fifth may show externally more or less as "dew-claws," but on the other hand they may be entirely invisible. Some traces of their metacarpal or metatarsal bones, more or less complete, are to be detected. These bones of the third and fourth toes are coalesced into a so-called "cannon-bone," which, however, always indicates its double character by a median groove.

Apart from the bony horn-cores, or pedicels projecting from the skull, the absence of incisor and canine teeth from the upper jaw gives a peculiar form to the bones concerned. These are covered by a hard fibrous pad, against which the forwardly-directed incisors and canine teeth of the lower jaw bite. Their function as cutting teeth rarely comes into play, and the mouthful of grass is rather torn away with a jerk of the head than clipped by the teeth. The grinders are $\frac{2}{3}$, have flat surfaces, bearing the crescentic ledges of enamel either single in the premolars or double in the molars, to which accessory enamel columns may be added. The form of the pattern is here, as elsewhere, of importance to the systematist.

The stomach has four compartments. These are named respectively the rumen, or paunch, the reticulum, or honeycomb, the psalterium, or manyplies, and the abomasum, which last is alone comparable to

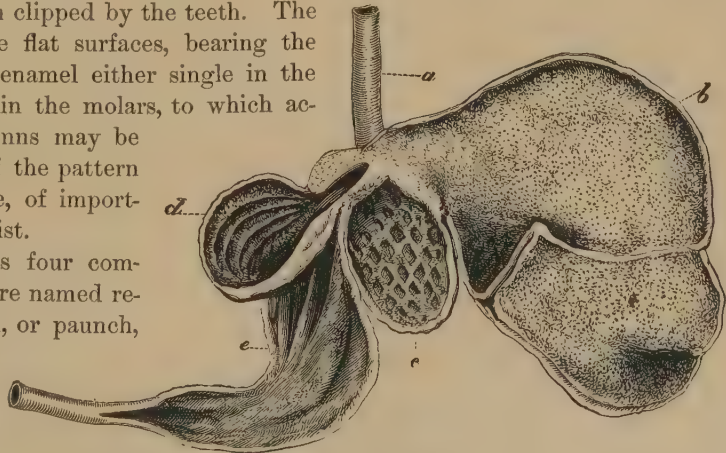


FIG. 136.—Stomach of ruminant. *a.* Esophagus. *b.* Rumen. *c.* Reticulum. *d.* Psalterium. *e.* Abomasum.

the glandular stomach of other animals, and furnishes the gastric juice, or rennet, of the calf.

These compartments are grouped in pairs, the rumen and the reticulum opening freely into each other, as do the psalterium and abomasum. The œsophagus opens into the stomach at the point of junction of the rumen and reticulum, so that solid particles of food may pass indifferently into one or the other, and are then driven about, from one to the other, by the muscular action of their walls. There is no such direct communication between the œsophagus and the psalterium; a groove is found, however, along the shorter curve of the reticulum, which when closed by muscular action does form such a direct channel of communication, and fluids may pass thus directly into the third and fourth stomachs, or indirectly through the first two. The paunch is the largest chamber; its form is frequently very singular, while the reticulum is generally rounded. The grass that is cropped during grazing is mixed with quantities of saliva and passed down into the paunch, by the juices of which and the reticulum it becomes partially sodden. When the animal is at rest the chewing of the cud begins, that is, the half-sodden fodder is thrown upwards into the mouth and there subjected to more complete mastication before it is returned to the third and fourth stomachs. The groove which renders this possible is then closed, so that the masticated food is now passed into the strainer-like psalterium. This compartment has its interior raised into high folds, which, on opening the stomach, fall asunder, like the leaves of a book, whence both the technical name and the familiar, manyplies. The surface of the mucous membrane is thus enormously increased in extent, and the food in being strained through it is pressed into contact with the surface of the folds. The relative size of the psalterium, in different genera, is a very characteristic feature. Occasionally, as in the musk-deer, the lamellæ are all of one height (primary), but generally there are alternating secondary lamellæ. These commonly number nine and ten respectively, but the surface may be still further enlarged by the appearance of tertiary and even quaternary lamellæ between the others. Owen first remarked that the chewing of the cud takes place by strokes in a constant direction in the typical ruminants, whereas in the camels strokes from side to side are employed.

The fourth stomach, as already observed, is that in which the food is first brought into contact with the gastric juice. This complexity of the stomach is obviously in adaptation to the nature of the food, and we accordingly find that the rest of the intestine is similarly adapted, chiefly by its great length and consequent large surface, for the absorption of the nutritive matters from the contents of the tubes.

The liver is comparatively simple in its divisions, and is possessed of a gall-bladder in oxen, sheep, and most antelopes, while that is absent in the deer and the tiny *Cephalophus* antelopes. The placenta in the typical ruminants is always cotyledonary. The patches may be numerous, as in oxen and antelopes, while they are restricted in number in the deer. The number of young at a birth varies much in the ruminants. The teats may be in the groin (that is, inguinal in position) or further forward, on the abdomen, and then called "abdominal."

We shall first discuss two sections of the ruminants which are evidently early offshoots from the main stem of development of this group. Both in external appearance and internal anatomy these forms, the camels and chevrotains, deserve to be separated from the typical ruminants. Both of them exhibit three characteristics which we must regard as more generalized than what we meet with in the ruminants, viz., that the metacarpals and metatarsals of the third and fourth toes do not become coalesced into a cannon-bone, or else do so only very late in life; that the placenta, instead of being restricted into patches as in the Pecora, is diffuse; and that horns are entirely

absent. These aberrant groups include respectively the largest and the smallest ruminating animals.

SUPER-FAMILY I.—TYLOPODA.

The name Tylopoda has been employed for the camel and its allies in reference to the spongy pads which cover the under-surface of the third and fourth toes, and on which the animals walk. The hoofs consequently do not carry the weight of the

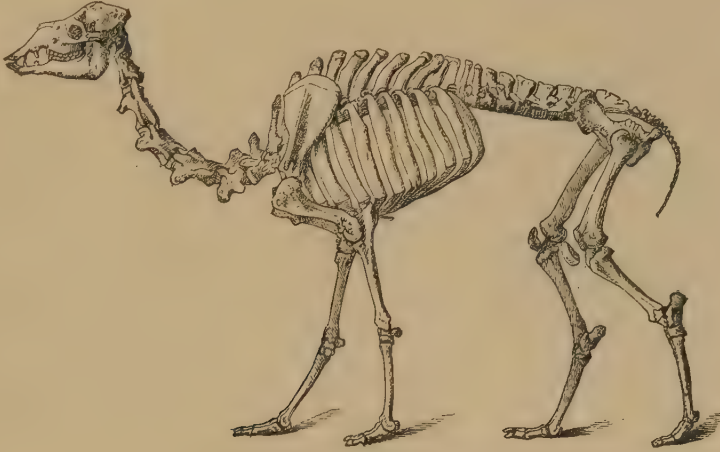


FIG. 137.—Skeleton of dromedary.

body, and are in fact little more than nails. The skin is covered with fine woolly hair, which is utilized for textile purposes.

The skeleton has many peculiarities; thus the third and fourth toes, which alone are present, instead of being symmetrical, taken together, are each symmetrical in themselves—indicating an independence which is further expressed in the incomplete fusion of their metapodials at the lower end. The skull has very short nasal bones, against which the premaxillary bones are applied. These, unlike other ruminants, contain, in the adult, the single outer tusk-like incisor on each side; the canines are tusk-like in both jaws, but do not project outside of the mouth; they are separated by a gap from the incisors and from the first premolars, which stand isolated, and are also tusk-like, while the rest of the molars have a very simple form of the ordinary type of ruminant grinder. That so many of the teeth are thus formed into lacerating organs is no doubt partly attributable to the absence of the antlers or horns of the Pecora. The neck is extremely long, but the cervical vertebræ are only present in the usual number. They are peculiar in as far as the vertebral artery pierces the arch of the vertebra and not the transverse process, a condition only known in the fossil perissodactyle *Macrauchenia*. The spines of the dorsal vertebræ are high, but do not contribute to the formation of the humps of the camels proper. In respect to the soft parts two peculiarities have already been referred to—the diffuse nature of the placenta, and the absence of the psalterium in the stomach. The rumen is furnished with “water cells” which serve to store up the fluid drained off from the food, and give the paunch a sacculated appearance from the outside. Another adaptation in the same direction in the economizing of the fluids of the body is observable in the conformation of the end of the snout. It is covered

with hair, but split by a deep median fissure running into the mouth. Connecting with the median fissure are shallower grooves leading from each nostril. The nostrils



FIG. 138. — Head of camel.

are oblique and may be completely closed by muscular action—a condition of great service to the camel in a storm of sand. Unlike all other mammals the Tylopoda have oval blood-disks, which are of the small size characteristic of ruminants generally.

The sub-order includes but one family (CAMELIDÆ), the living representatives of which are all referable to two genera, *Camelus* and *Auchenia*. These are most widely separated geographically, for while the camels are confined to Asia and Africa the llamas and their allies only occur in the mountainous tracts of western South America. There they are found wild as well as domesticated, and until the invasion of the country by the Spaniards were the only domesticated animals possessed by the aborigines. The camels, on the other hand, with the exception of certain problematical wild ones to be referred to afterwards, are all domesticated.

Apart from their greater size, and the presence of one or two humps, the camels are distinguished from the llamas by possessing a single spongy pad investing the under-surface of both toes, and by the smaller development of the hoofs or nails. These differences explain themselves when we consider the different habitat of the two genera. The neck is curved, the ears small, and the tail hairy only at the extremity. The dentition is *i.* $\frac{1}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{5}{2}$, while in the llamas the molar teeth are generally only $\frac{4}{2}$, the first upper premolar not being succeeded by a permanent grinder, and the first lower one generally falling out early.

The Camel or Dromedary (*Camelus dromedarius*), the most familiar member of this family, is only known in a state of domestication. It has been suggested that it may be descended from the Asiatic species, which is found in a wild, or at any rate in a 'feral' state; but there appears to be no sufficient evidence to maintain this view. Arabia is probably the original centre of distribution of this most characteristic desert species, and wherever the Arabian people have gone they have taken the camel with them. Although capable of withstanding the burning sun of the desert, the camel is not found nearer the equator than 12° N. latitude, and droops when forced out of its natural habitat. The hot season and the flies necessitate a certain amount of migration to the Arabs and camels of the more southerly regions, and it is not uncommon to meet with herds of females and young at the beginning of the hot season making for the north. Immense numbers of animals are employed in Africa and Arabia; few of these meet with any death but that which marks out with bleached bones the paths of the caravans on the otherwise trackless desert.

In length the camel averages ten to eleven feet, with a height of between seven and eight at the shoulder. The single hump which characterizes this species is apparently formed in adaptation to the conditions of its existence. Only during a comparatively short period of the year does the camel have abundant moist herbage; it is then that the hump increases in size, forming a storehouse of food which is drawn

on when required. It is formed chiefly of fat, the spines of the dorsal vertebræ being no longer than the immense length of the neck would lead us to expect. The coat is formed of fine hair, woolly in places, but is apt to be shaggy in older animals. It is thickest about the neck, throat, and tail, and entirely absent in the breast and knees, where the skin is thickened into horny pads. The prevailing color closely resembles that of the sand of the desert; darker animals are not uncommon, and pure white riding dromedaries are occasionally met with, and much valued.

The rutting season lasts for some eight or ten weeks, from January to March; the males are then very vicious, biting at each other and at their drivers. During this time a pendulous flap, that hangs down from the fore part of the soft palate and rests on the upper surface of the tongue, is greatly enlarged, and may be blown out into a sac-like form, on one or both sides, from the mouth. The protrusion is accompanied by a belching noise. Owen suggests that ordinarily the flap may be employed to moisten the back of the mouth and tongue during the long-enforced abstinence from water which the animal has often to undergo. As is the case with other gregarious ruminants the camel has its peculiar cutaneous glands; these are situated at the back of the head, and emit a very offensive odor during the rutting season. After a period of gestation of about a year one calf is dropped, and a year after birth the young camels are weaned. Not till they attain the age of five are they mature, or fitted to bear burdens, but they are frequently employed before they are so old. No bit is used in riding or driving the camel; a sort of leathern noose serves to constrict the nose of the beast of burden, and the hygeens, as a rule, have one nostril perforated by a second bridle.

Some interesting facts with regard to the natural history of the dromedary are given by Sir S. Baker, in his "Albert Nyanza." "There is no animal so stupid as the camel,—he eats anything green, and must always be accompanied by watchers, to keep him from the plant known as 'camel poison.' The most fatal plant is a creeper, very succulent, and so beautifully green that its dense foliage is most attractive to the stupid victim. The stomach of the camel is very subject to inflammation, which is rapidly fatal. I have frequently seen them, after several days of sharp desert marching, arrive in good pasture, and die within a few hours of inflammation, caused by repletion. It is extraordinary how they can exist upon the driest and apparently most innutritious food. When other animals are starving the camel manages to pick up a subsistence, eating ends of barren, leafless twigs, dried sticks of certain shrubs, and the tough, dry, paper-like substance of the dome palm, about as succulent a breakfast as would be a green umbrella or a 'Times' newspaper. The camel is intensely greedy in abundant pasture, and the poison bush becomes a fatal bait. The camel is not understood in Europe, he is not docile or patient,—quite the reverse,—the males are often dangerous, exceedingly perverse, and excessively stupid. Accounts are exaggerated of the length of time a camel can go without drinking; it depends entirely on the season and the quality of food. In Europe sheep require little water when fed on turnips, so does the camel exist almost without drinking during the rainy season when pastured upon succulent and dewy herbage. During the hottest season they are led to water every alternate day, but when upon the march across deserts, where no water exists, they are expected to carry a load of from five hundred to six hundred pounds, and to march twenty-five miles a day for three days without drinking, but to be watered on the sixth day. Thus a camel should drink the evening before the start, and he will carry his load one hundred miles without the necessity of drinking; not, however, without

suffering from thirst. This peculiarity of constitution enables the camel to overcome obstacles of nature that would otherwise be insurmountable. He can travel over scorching sand and never seeks the shade. When released from his burden he kneels by his load in the burning sand, and luxuriates in the glare of a sun that drives all other beasts to shelter. The peculiar spongy formation of the foot renders the camel exceedingly sure, although it is usual to believe that it is only adapted for flat, sandy plains. I have travelled over mountains so precipitous that no domestic animal but the camel could have accomplished the task with a load. This capability is not shared generally by the race, but by a breed belonging to the Hadendowa Arabs, between the Red Sea and Saka. There is quite as great a variety in the breeds of camels as of horses. Those most esteemed in the Soudan are the Bishareen, not so large as others, but exceedingly strong and enduring.

"The average value of a baggage-camel among the Soudan Arabs is \$15.00, but a good 'hygeen,' or riding dromedary, is worth from \$50.00 to \$150.00. Such a camel is supposed to travel fifty miles a day, and to continue this pace for five days, carrying only his rider and a small water skin, or girba. His action should be so easy that his long ambling trot should produce that peculiar movement adopted by a nurse when hushing a child to sleep upon her knee. This movement is delightful, and the quick elastic step of a first-class animal imparts an invigorating spirit to the rider, and were it not for the intensity of the sun he would willingly ride forever. The difference of action and of comfort to the rider between a common camel and a high class hygeen is equal to that between a thoroughbred and a heavy dray horse."

It is interesting to note that the further north we go in Africa into districts where the atmosphere is moister and herbage comparatively abundant, the heavier does the camel become. A similar phenomenon has been referred to in the contrast of southern and northern breeds of horses.

Before the late war several camels were imported for military service on the deserts of the western territories. They were neglected for many years but continue to increase, and are now numerous in some parts of Nevada, Arizona, and New Mexico.

The Central Asiatic species, *C. bactrianus*, or Bactrian camel, is an animal of larger size than the dromedary, and is adapted to its colder habitat by a more abundant coat. The presence of two humps, one on the withers, the other in front of the rump, distinguishes this species at first sight. These humps decrease in size during the winter, but in early summer, when the herbage of the steppes, uninviting as it may appear, is comparatively abundant, the camels are freed from their bondage and fatten at liberty. The inhabitants of the steppes, being a pastoral people, do not permit the females to have the same freedom, but keep them in the neighborhood of their tents for the sake of their milk. Some comparatively unexplored districts of Central Asia are said to shelter wild camels of this species: it is still uncertain whether these have not merely escaped from domestication.

The representatives of the camels in the new world are confined to the west coast of South America, and are found there chiefly at high altitudes in the Cordilleras, or on lower ground towards the south of the continent, where they find the lower temperature under which alone they appear to prosper. Two of the forms, the guanaco and the vicuna, are found in the wild state; the other two, the llama and the alpaca, have been domesticated for centuries, and are perhaps only the altered descendants of the foregoing. They are, however, generally described as separate species, forming the genus *Auchenia*. Compared with their old world relatives the species of *Auchenia*

are of diminutive size; they lack the hump, and, except for the long straight neck, large head, and long ears, are decidedly sheep-like. The toes are more distinctly cloven than in the camels, each being provided on its under surface with a callous pad, while interdigital glands pour their secretions into the cleft. Such callosities as mark the knees and breast of the camel are only found in the llama, and are perhaps attributable to its conversion into a beast of burden. In all the coat is much more abundant than in the camels, and yields wool of greater commercial importance.



FIG. 139. — *Camelus bactrianus*, Bactrian camel.

The largest species is the Guanaco (*A. huanaco*), which attains a length of between seven and eight feet, and a height of nearly four at the shoulder. The absence of the hump, and the carriage of the slender neck, give greater elegance to this animal than the camel can boast of. This species has the most southerly distribution of the four, being found most abundantly in the southern Andes, and on the colder plains of Patagonia. Like the others it is gregarious; the herds are sometimes of large size, but generally number from six to thirty individuals, all of which, with the exception of the guiding male, are females. The body is entirely covered with a dirty brown fleece, the color of the coat darkening on the head but paling on the under-parts. The tail is carried erect, and is better provided with hair than in the camel. The ears are

half as long as the head, and the hearing is unquestionably acute, for the guanacos are described as being exceedingly shy and wary. They partake of the curiosity so common among wild animals; and were it not for this trait they would be unapproachable, at least in mountainous districts. When attacked the guanacos have recourse to a singular method of defence, which is shared by the other species,—they forcibly expectorate a mixture of saliva and partly-chewed food in considerable quantity, a habit which has gained them some notoriety in zoological gardens. Darwin, who studied the guanacos in Patagonia, found that, unlike camels, they readily take to water, and swim from island to island. Like other ruminants they are fond of salt, and will drink salt water. The rutting season is in August and September; then the males fight together, their teeth leaving serious wounds in the hides of the vanquished. The females go eleven months with young, and suckle the calf for four months before it is weaned.

The supposed domesticated variety of the above, the Llama (*A. llama*), is employed as a beast of burden on the elevated plateaus of Bolivia and Peru. Formerly it was used in large numbers to transport silver from the mines towards the seaboard, and to bring back the necessaries of life, but it has been largely replaced of late years by mules. From one to two hundred pounds are loaded on the llama, and with this it covers from six to twelve miles a day. The marks of its servitude are evident in the callosities on the knees and breast, the larger footpads, and the diminished size. The head and ears are also shorter than in the guanaco, and the coat, instead of being uniformly brown, is extremely variable in its coloring. Only the males are employed for transport; the females are reserved for breeding purposes, and are allowed to graze at their will during the daytime, being merely gathered into folds at night. Although the distance traversed by the llama appears so insignificant yet this method of transport is very cheap. The animals if well treated are willing and hardy, require no forage except what they find on their route, and furnish excellent meat, especially when young.

The Vicuña (*A. vicunna*) is decidedly smaller in stature than the foregoing. It yields an extremely fine curly wool, from which fabrics of silky fineness are made which are one of the articles of export of Bolivia. The coat is reddish brown above, but an apron of long white hair falls down between the fore-legs, and is continued along the flanks. The vicuñas are found in elevated grassy spots on the Cordilleras; they avoid stony and rocky places, and only descend from their inaccessible homes in the warm season. They are hunted both for their flesh, which is excellent, and for their wool. Most are obtained by being driven into a sort of corral, where they are readily secured by means of the lasso and bolas. In their habits they closely resemble the guanacos, living in herds formed either entirely of young males, or else of females with one older male who acts as sentinel for the family. If he be wounded the females with him press closely round, and often fall victims to their sympathy, while if one of the females be wounded she is quickly deserted by the rest of the herd.

The Alpaca or Paco (*A. pacos*), the fourth species of *Auchenia*, is decidedly more sheep-like than any of the other forms, and is kept in large flocks on the elevated plains of the Andes by the Peruvian Indians. Whether it is to be regarded as merely a domesticated vicuña, or whether there may be some of the guanaco blood intermixed in the stock is a point which has not yet been satisfactorily determined. Like the llama its color varies much, being perhaps most frequently of the pale brown hue of the vicuña, but gray and even black varieties are of common occurrence. It has for

ages furnished the aborigines of Peru with the fine wool for their blankets and ponchos, but this has only been introduced as an article of commerce to the world at large within the last fifty years. Its capabilities for certain fabrics were first recognized by Sir Titus Salt, whose factories at Saltaire in England have attained immense importance through this branch of wool manufacture. When shorn regularly every year the wool grows some eight inches in length, but if unshorn grows much longer. There appears to be no regular pushing off of the fleece in the llama and alpaca such as we see in the sheep. Several llamas were kept in the Zoological Gardens in London for some years without showing any indication of shedding the coat, but at last traces



FIG. 140.—*Auchenia vicunna*, vicuña.

began to appear and the animals were then shorn. The appearance of the animals without their "sheep's clothing" immediately discloses their camel affinities. Many attempts have been made to introduce the alpaca into other parts of the world. All these have failed more or less signally, for the animals appear to droop and diminish in numbers in the absence of the climatic conditions necessary to them. All of the species of *Auchenia* are comparatively familiar in zoological gardens; but visitors are generally advised to keep at a safe distance, for the intrusion of strangers is frequently resented in the unpleasant manner already referred to.

In the fossil Camelidæ which once abundantly existed in North America we find the dentition more complete than in the adults of the forms living at the present day. So much might be argued indeed by comparing the milk-dentition of the living forms

such as *Auchenia* with the adult dentition. As Professor Cope has pointed out, the study of the teeth of the *Auchenia* furnishes us with a recapitulation of the gradual loss of certain teeth which the living Camelidæ have undergone as compared with their ancestors. The earliest fossil camel, *Poebrotherium*, from lower miocene strata, was possessed of all the incisor and premolar teeth of the typical ungulate, and had no cannon-bone. *Protolabis* and *Procamelus*, from the upper miocene beds, had the full complement of premolars, but had lost the first and second incisors, while the *Pliauchenia*, from the same strata, had only three premolars. As we have seen these are



FIG. 141. — *Auchenia pacos*, alpaca, paco.

reduced to two in the camel and to one in the llama. In respect to the abundant camel remains in North America Wallace says, "We thus find the ancestors of the Camelidæ in a region where they do not now exist, but which is situated so that the now widely-separated living forms could easily have been derived from it. This case offers a remarkable example of the light thrown by palæontology on the distribution of living animals; and it is a warning against the too common practice of assuming the direct land connection of remote continents in order to explain similar instances of discontinuous distribution to that of the present family."

SUPER-FAMILY II. — TRAGULINA.

The animals included under this super family are generally known as Chevrotains, and were for a long time confused by zoologists with the family Moschidæ, of which the musk deer is the sole representative. They are the smallest of all ruminants, recalling in form and size some of the larger rodents rather than the group to which they are anatomically related. We figure the commonest species, the Kanchil of the Malays (*T. kanchil*), which is common in various islands of the Malay Archipelago. The following contains a summary of Professor A. Milne-Edwards' researches on this interesting group. In all the forms the head is small, delicate, and pointed; the eyes very large; the ears small and almost naked; the tail short; the body high, especially behind, and habitually much arched; the hoofs are slender, especially the anterior. Their gait is similar to that of the agouti, being composed of a series of short bounds, in which the posterior part of the body is much elevated. When they lie down, instead of stretching out one leg and doubling up the other, a habitual attitude in most deer, or lying on the side like oxen, they double both fore legs under them. The group is not confined to the islands named above, but various species extend on the continent of Asia through Hindostan to Cochin China.

Before looking at the various species we shall shortly consider some of the anatomical peculiarities of the group. A median gap exists between the incisors of the right and left sides in the lower jaw. The upper canines — grooved longitudinally on the outside — are strongly developed in the males, in correlation to the absence of horns, and curve backwards and downwards, diverging from each other as they do so. One of the most peculiar features in the skeleton is the tendency of ligamentous tissue to ossify; the membranous fascia, for instance, that covers the muscles of the back is converted, in the male, to a connected series of thin bony plates. The metacarpal and metatarsal bones for the second and fifth digits are as long as those for the third and fourth. The latter may be fused into a cannon-bone, or, as in the genus *Hyemoschus*, such fusion may not take place at all (metacarpals), or only very late (metatarsals).

The stomach of the chevrotains is very different from the characteristic ruminant stomach, for the psalterium is absent, or at any rate is represented only by a short tube, whereas in the musk deer it has the characteristic "many-plyed" structure. The blood-corpuscles, although in form like those of the other ruminants, measure only from $\frac{1}{10000}$ — $\frac{1}{12000}$ of an inch in diameter. The brain is very simple in structure, much more so than that of the ruminants generally, and the mode of connection of the fœtus with the womb is different, for the vascular tufts on the chorion are scattered all over it, and not concentrated in cotyledonary patches.

The structure of the cannon-bone referred to above is used by naturalists in the separation of the genera *Tragulus* and *Hyemoschus*. The latter embraces only a single species, *H. aquaticus*, while the other species, five in number, are ranged under *Tragulus*.

T. javanicus, the Javanese species, is of small size, eighteen inches long; the coat is yellowish, with a tinge of black on the upper parts, and of rufous on the sides. The neck is gray, the throat marked with three white bands. The tail is long, brown above and white below and at the tip. This species appears to be common in Java, Penang, and the Sunda Islands; it is easily tamed.

T. napu, a Sumatran form found near the sea coast, is of larger size, and appears to be of a nature more indolent than the other species. It has five white bands on the throat, one of which is median.

T. kanchil is the smallest species and is found in the depths of the forests of Borneo, Java, and Malacca. According to Bock its Malay name means "little," and unlike the first species it is impossible to keep it alive when caught. It is snared by the natives for the sake of its flesh. Raffles relates that its agility and its cunning are proverbial among the Malays; for example, it is said to be able, when pursued by dogs, to jump up and hook itself to branches of trees by its curved canine teeth, and frequently feigns death prior to effecting escape. The black line along the back is very distinct in this species, which is further characterized by three white bands on the throat. *T. stanleyanus* is intermediate in size between the *napu* and the *kanchil*, is marked on

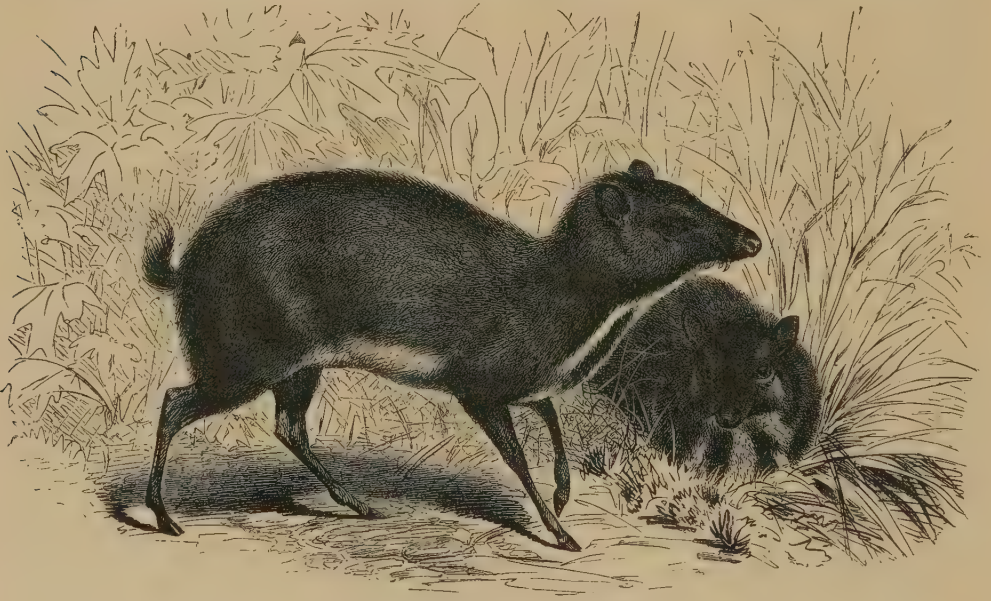


FIG. 142. — *Tragulus kanchil*, kanchil.

the throat like the former, but the neck is reddish and not gray. It is found on the Sunda Islands. *T. meminna* is also of medium stature. The yellowish coat is marked with white bands and spots, so that this species is readily distinguishable from all the others. Its home is Ceylon, but appears to pass through Hindostan to Nepaul. Timid by nature, it is said to inhabit the thick jungle, and to conceal itself in crevices of rocks. It is solitary except at the mating time in June or July. The female carries her young till the end of the rainy season, then she drops two at a birth, hardly larger than big rats, but already presenting the color of the parents.

Hyamoschus aquaticus, the "Biche Cochon" of the French colonists of the Gaboon, Water Deer of the colonists of Sierra Leone, and Boomorah of the natives is the largest representative of this sub-order, and differs from the others in the shortness and thickness of the legs and the heaviness of the body. The coat is brown, marked on the flanks with white bands and spots, while the throat has five longitudinal stripes. Little is known of its habitat, and it is even questionable whether it deserves its English name of "water deer."

SUPER-FAMILY III. — PECORA.

In our discussion of the anatomy of the ruminants we have already summarized the chief anatomical features of our third super-family of ruminants, the Pecora or Cotylophora. They, in fact, are the ruminants *par excellence*, and the camels and chevrotains are isolated groups with few living representatives, departing from the typical ruminants in the particulars recorded above. It will be unnecessary then to repeat here the characteristics of the Pecora, and we shall now proceed to discuss the four families into which they are conveniently divided.

Sir Victor Brooke has recently contributed to the Zoological Society of London a valuable paper on the classification of the family CERVIDÆ, — which embraces the deer, — and a revision of the species, to which we are indebted for many of the facts recorded here, as well as for the arrangement of the species. The musk deer and the giraffe form two such aberrant sections of the sub-order under consideration that a summary of the points in which the present family differs from the Bovidæ will serve best to introduce an account of the special anatomical features of the group. The Cervidæ are sometimes spoken of as the solid-horned ruminants, as distinguished from the hollow-horned oxen and antelopes. The horns or antlers, generally present in the male sex only, are annual outgrowths of the frontal bone which are at first covered by soft, hairy skin, the 'velvet'; this is, however, rubbed off when the antlers have attained their full size. Three parts are distinguished in the antlers, the pedicel, which projects from the skull; the burr, or rough circular protuberance; and the beam, which constitutes the free part of the antler. Burr and beam are shed once a year when the hair is shed. The main branches of the antler are the 'tynes,' and the secondary branches 'snags,' together these constitute the 'points,' and as the tynes and snags form a pretty accurate measure of age, a deer is described as of so many points in hunting parlance. The closest connection is to be observed between the antlers and the reproductive function, as the antlers are employed in combat between the males at the rutting-time, and the successful males are generally those which have just attained their full size, the snags in these being sharper than they are in the older bucks.

Besides the reindeer, in which the female is always antlered, occasional abnormal development of antlers has been observed in the female of various forms. Judge Caton states that he has frequently observed Virginia does with small, simple, velvet-clad antlers, and describes a skull from the National Museum in which the beams are six inches long. The same phenomenon has been observed in the Columbian deer and in the moose. At the castle of Aschaffenburg, in Germany, an antlered skull of a female moose of eight points has the following inscription:—

"Schau, O Welt, ich bin ein Weib
Und trag' des Mannes Wappen
Ich hab' auf meinem Kopf
Was für ihn ist erschaffen!"

In England and Germany many instances have been recorded of antlered roe-deer, many of which were fertile animals. Mr. Alston makes the suggestion that these are instances of atavism, and calls attention to the fact that the phenomenon is very

uncommon in the old-world deer, embracing the most highly specialized genera. He is inclined to believe that the horns were first developed in both sexes as means of defence, and only afterwards became modified under the laws of sexual selection. He justifies this view by pointing out that the females of the Camelopardidæ, of the Bovidæ (with the exception of twelve genera of antelopes), and one of the least-specialized Cervidæ (*Rangifer*) are always provided with horns. The normal absence of these in the females of the Cervidæ is explainable by the strain on the constitution caused by their yearly renewal not being supportable simultaneously with the strain due to parturition. The antlers of the male are shed at the time of the dropping of the fawns, a provision which perhaps secures the safety of the young from the viciousness of the parent, and which may also have been a habit acquired through natural selection — those males being best fitted for the struggle for existence in which sharp, newly-formed antlers



FIG. 143. — *Cervulus muntjac*, muntjac.

replaced those injured in combat. The hollow-horned ruminants, on the other hand, possess similar processes of the frontal bone enveloped in horny sheaths which (with the exception of those of the prong-horned antelope) are persistent; only the females of a few genera are hornless. In the Cervidæ upper canine teeth are present in both sexes with few exceptions, but they are absent from all Bovidæ with a single exception. The distal ends of the second and fifth metacarpals are present in some Cervidæ, but are absent in all Bovidæ. The two proximal joints of the second and fifth digits are present in the Cervidæ and absent in the Bovidæ. The cotyledonary patches of the placenta are few in number in the Cervidæ, but numerous in the Bovidæ. A gall-bladder is absent in the former and present in the latter.

In his researches on the classification of the Cervidæ Sir V. Brooke finds that the new world forms exhibit certain important peculiarities, which distinguish them from those of the old world, and he accordingly proposes to divide the deer into two

groups, 1, Plesiometacarpi (mostly old world forms), in which the near ends of the second and fifth metacarpals remain, and 2, Telemetacarpi (mostly new world forms), in which the distal ends of these bones remain. In the former group the hinder part of the nasal cavity is not divided by the vomer into two distinct chambers, while in the deer of the new world it generally is. There are also certain tufts of hair on the legs, which are singularly constant in their position. In the old world deer the tufts of hair on the hinder cannon-bones, when present, are above the centre, and there are never any tufts on the inside of the ankle-joint, whereas the converse obtains with the deer of the new world.

The first genus which we shall consider in the group of Plesiometacarpi embraces the Muntjacs, small animals, of solitary habits, which are found in India and China. The commonest species, *Cervulus muntjac*, occurs in British India, Burmah, the Malay peninsula, and also in Sumatra, Java, and Borneo; in which islands, however, it appears to attain a larger size than on the mainland. The other species, *C. lacrymans* and *reevesii*, are from northern and southern China respectively. The stature of the muntjacs is small, — twenty-six inches at the shoulder, — the hair is smooth and short, the limbs are short, and the back arched and high behind. The antlers of the male are peculiar chiefly for the length of the pedestals which connect them with the frontal bones; they have short brow-antlers, which project inwards, as do the antlers themselves. Sir V. Brooke describes their habits as follows: "They are fond of hilly ground covered with forest, and, in common with all deer, exhibit much partiality to particular spots. Their alarm cry is a sharp, shrill bark; when attacked by dogs the males use their sharp, exerted canines with extraordinary severity, inflicting upon their opponents deep, and at times even dangerous wounds. These teeth being very loose in their sockets, it has been imagined by some that the animal possesses the power of moving them, so as to give greater effect to the blow when striking with them." The general color is a yellowish red, the chin, throat, and belly being, however, white, and the face and legs brown.

Closely allied in certain respects to the muntjacs is the genus *Elaphodus*, embracing two Chinese species, the antlers of which are, however, unbranched. The frontal cutaneous glands, so characteristic of the muntjacs, are absent.

The genus *Cervus* has been subdivided into a number of sub-genera, which are, for the most part, confined to special zoogeographical regions. *Rusa*, for example, is confined to the Indian region, and embraces twelve species, of which one of the best known is *C. aristotelis*, the Sambar. Here the antlers are between two and three times the length of the head. A strong brow-tine forms an acute angle with the beam, which bifurcates at the end. The color is brown, and the neck maned. The Bornean Sambar, *C. equinus*, although darker, and with a bushier tail, is probably only a small race of this species. Several little-known species are described from the Philippine Islands, and a better known form, *C. hippelaphus* (in which the inner tine is much longer than the outer), occurs in Java, and, according to Wallace, has been introduced by the Malays, who are fond of the flesh, into various remote islands in which they have settled. *Rucervus* is also from the Indian region. Its powerful brow-antler projects forwards, at right angles from the beam, which is twice bifurcated.

Axis, from the western portion of the Indian region, has antlers about three times the length of the head (*C. axis*). The brow-tine forms less than a right angle with the beam, which bifurcates at half its length, the anterior fork being longer than the

posterior. Both sexes, at all ages and seasons, are distinctly spotted. The stature is decidedly smaller than that of the sambur and Java deer.

Pseudaxis (*C. sika*, from Japan, *C. caspicus* from the mountains southwest of the Caspian) has antlers about twice the length of the head, with a short upwardly directed brow-tine, an anterior tine half way up the beam, and a short posterior tine near the top. The metatarsal tuft is whitish, the coat spotted in summer, brown in winter; black bands on each side of the pure white anal disk form a cross with the narrow black streak along the back of the tail.



FIG. 144.—*Cervus axis*, axis deer.

Cervus proper has seven species, with one new world form, the wapiti. The antlers in this group have a second brow-tine, and the terminal posterior tine is more strongly developed than the anterior. The neck is maned, the young spotted, and a lighter disk than the general color surrounds the tail. Two species are of particular interest, which we shall describe more in detail, the red deer of Europe (*C. elaphus*) and the wapiti of North America (*C. canadensis*).

The Stag, or Red deer, attains a length of seven feet, with a height at the shoulders of over four feet. The hind is considerably smaller. The brow-antler projects forwards and upwards, not downwards over the face as in the wapiti. The coat is formed of coarse hairs and fine wool, the former prolonged on the throat and chest. The



Cervus elaphus, red deer.

latter, more abundant in winter, is grayish brown, which results in a grayer winter coat. The hair on the face is darker, and round the tail paler than the rest of the coat. Only the young are spotted.

In the language of the hunt various names are given to red deer of different ages. In the second year, while the antlers are unbranched, the male is a 'brocket,' in the third year a 'spayad,' in the fourth a 'staggard,' and only in the fifth do the antlers attain the tines characteristic of the adult, when the name 'stag' is for the first time applied to it. As the tines increase in number to from ten to sixteen points, the stag is then called a 'great hart.'

The red deer is still found over all Europe and a great part of Asia, with the exception of the highest latitudes. It is, of course, exterminated in populous districts, and is now only found in deer forests, where it is carefully preserved, or in wild tracts of country, such as occur in the mountainous districts of Austria, the Caucasus, and southern Siberia. The larger herds are formed of hinds and young stags, the smaller of stags of greater maturity, while the harts live a solitary life except at the time of the rut. Both herds and solitary animals seek lower level, where food is more abundant, during the winter time; the evening and night constitute the feeding time. For fleetness and agility the red deer is unexcelled, even broad arms of water offer no obstacle to its progress, for it is an excellent swimmer. All the senses are extraordinarily acute, as is generally the case with the timid and wild members of this order. The temper of the stag is, however, neither to be depended on in the wild or tame condition, for both hunters and keepers have been frequently fatally charged unexpectedly, the brow-antlers being employed in such attacks. Nor is he kinder to his kin, for he maltreats the hinds, especially at the rutting time, and is then exceedingly dangerous to approach.

The food of the red deer alters with the seasons of the year; in winter buds, bark, lichens, and moss, in spring young shoots and herbs of various kinds. During the rutting time the stags eat very little, merely fungi, — this time lasts during September and part of October. The hind carries her young for ten months, and tends it carefully, especially during the first helpless days. In three years the hind is full-grown, but the stag requires a longer time to be able to secure for himself in combat with older stags the privileges of maturity.

The horns of the red deer, while very vascular, were at one time regarded as a potent medicine, but the Chinese alone now appear to retain this idea. The horns of the allied *C. maral*, of Siberia, are bought eagerly at the Siberian border in this condition. It is asserted that this species has been recently successfully domesticated by Cossacks, in the neighborhood of Kiakhta, in Siberia, but that the horns of the tame animals do not command so high a price as those of the wild.

Exceeding the red deer in stature, but resembling it in the general conformation of the antlers, the Wapiti, or American Elk (Wawaskeesh of the Crees, and La Biche of the Canadian French), *C. canadensis*, is one of the noblest members of this family. It differs from the red deer in the following particulars: The hoofs are broad and semicircular, instead of being narrow and triangular; the tail is much shorter; the coat is redder in color, and in winter, over the withers, is softer; the pale disk round the tail is much more extensive.

The distribution of colors in the coat is described by Baird as follows: "In summer the general color is of a light chestnut-red, darkest on the neck and legs; the throat and median ventral line are dusky, almost black; the chin is dusky, with a narrow patch

of light yellowish on either side of a broad median, yellowish patch under the head; the rump is yellowish white, bordered by a dusky band which extends down the posterior face of the hind legs. As in other Cervidæ the winter coat is decidedly grayer."

The wapiti was at one time very widely distributed on the American continent, for it was found from the Atlantic to the Pacific coast, and from New Mexico to Hudson's Bay. It is now uncommon in the States except about the western tributaries of the Mississippi, but still occurs in large numbers in northern California and Oregon. There



FIG. 145.—*Cervus canadensis*, wapiti.

it is found, says Newberry, in the wide stretches of "tule" bordering the rivers and lakes, and attains a larger size than that east of the Rocky Mountains, up to 1,000 or even 1,200 pounds. They are also pretty numerous amongst the clumps of wood skirting the plains of the Saskatchewan and about the upper waters of the Missouri, where they once were found in large herds, but now live in small families of six or seven individuals. They feed on grasses, on young willow and poplar shoots, and the hips of the *Rosa blanda*, which forms much of the underwood in these districts. All observers agree in describing the call of the wapiti during the rutting time as different from that of the red deer. The "belling" of the latter is a distinct roar, like that of a panther,

while the wapiti, like the Cashmere stag, *C. cashmerianus*, emits a loud squeal, terminating in a more guttural tone. The rutting season lasts only for a short time in September, just before which the velvet is rubbed off the antlers. The call of the stags has been described as a prolonged whistle, apparently coming from a distance; this is succeeded by three or four barks, and finally by a low, smooth bellow. Sometimes the whistle is heard alone. The stags have fierce combats with each other, antlers being occasionally found locked inextricably together. They recover their condition after the rut in November, when the best hunting season begins. The females drop their young in May or June, retiring then to thick brush. The annual gradual growth of the horns resembles that of the red deer, a stag requiring six years to attain a 'full head.'

The antlers of the wapiti reach a considerable size; a good pair of points weigh, with the skull, 40 pounds, measure from burr to tip, on the curve, 52 inches, with a spread from tip to tip of 41 inches, and are 12 inches in circumference above the burr. They are of a deep brown color except the points, and are covered with little warty protuberances, arranged in lines, and separated by longitudinal grooves. The first brow-antler is more depressed toward the facial line than is the case in the red deer.

The gait of the wapiti is a long swinging-trot, which, if hotly pursued on horseback, they exchange for an awkward gallop; if the trot be once broken they are easily ridden down, although they have the advantage of a horse on very rough ground. They are stalked in certain districts, and are more readily approached than the Virginia deer. The females of the small herds act as sentinels.

The sub-genus *Dama* embraces the Fallow Deer (*C. dama*), a form of much smaller stature than the foregoing, the natural range of which is from Spain and Sardinia, to Greece and as far as Palestine, but which has led a domesticated life in European deer parks for many generations. Both sexes are marked in summer with white spots distributed irregularly over the sides on a brilliant fawn ground, the spotted regions being bounded by indefinite white lines; these marks are exchanged for a more uniform coloring in winter. The tail and rump have black marks as in the Japanese deer. The palmated antlers are about twice the length of the head, the tines on the upper half of the antler rising from its posterior surface.

The remaining genera of Cervidæ, forming the group Telemetacarpī, have the distal ends of the second and fifth metacarpals remaining. Three of these genera, almost exclusively confined to the old world (*Alces*, *Hydropotes*, *Capreolus*), share the structure of the skull, and the arrangement of the hair-tufts at the ankle-joints, referred to above as characteristic of the foregoing old-world forms.

As the genus *Cervus* has extended (in the wapiti) from the old into the new world, so we find the Moose, or Elk as it is called in Europe, common to both. In the old world its range extends from Sweden through Lithuania, Northern Russia, to the forests of the Lower Amoor as far south as the mouth of the Ussuri in latitude 48°. In the new world it extends on the west coast from the shores of the Arctic Ocean nearly to the Columbia River. Further east its northern limit is about 65°, and thence it extends southwards through British North America to the Northern States. It is rarely found east of the Saguenay, but is abundant upon the south side of the St. Lawrence, in the provinces of Quebec, New Brunswick, and Nova Scotia, and in Northern Maine. In the first-named province its numbers have increased within recent years owing to a total prohibition of moose hunting, which expired in the fall of 1883. Some naturalists have attempted to find specific differences between

the European and American forms, but they are generally united under the scientific name *Alces malchis* or *americanus*. The horns of the moose are very characteristic in shape; they are dichotomous, both main branches being palmated, the posterior one, however, of much greater dimensions than the anterior. An average full-grown pair weighs, with the skull, seventy pounds; the posterior branch measures thirty-eight inches in length, with a spread at the furthest distant points of forty-six inches,



FIG. 146. — *Alces malchis*, moose.

and has twenty-nine snags. In the first year the horns are only knobs an inch high, attain the length of a foot the second year, and only become palmated in the third year. The horns are cast in December, sprout again in April, and in June attain their full size. When the velvet is first stripped off they are beautifully white.

The head is of great size and clumsy shape, this being in great part due to the excessive development of the cartilaginous nasal septum, and of the upper lip, which is fitted rather for browsing upon young shoots than for permitting the cropping of short grass. Only a small, triangular, bare spot is left in front of the nostrils, the rest of the

large muzzle being hairy. The stature of the moose is considerable—a full-grown male standing as high as a horse. The neck and body are short, but the legs are long.

The coat is, in summer, fulvous on the upper parts, but yellowish below. It possesses both long, coarse hair, and finer wool, the former being longer upon the neck and withers, and forming a sort of beard on the throat. The long, asinine ears are lined with grayish or dingy white. The under side of the tail, which is from ten to fifteen inches long, is also white; but with the approach of winter these hues change through a grizzly coat to a blackish gray which becomes darker with age. The young, of which one or two are dropped in April or May, are sandy brown, and unspotted.

For its flesh and for its hide, which yields an admirable leather for mocassins and snow-shoes, the moose is hunted in various ways at different seasons. In winter they are generally followed on snowshoes, when they are readily overtaken if once seen. In summer, again, the moose when plagued by mosquitoes very frequently take to the water, where they feed chiefly on water-lilies, and although excellent swimmers they are not hard to secure. Again, they are frequently killed in the snow-yards, or driven into a sort of corral when they become an easy prey. But the regular moose hunt is of greater difficulty. Here is a description of the Indian method of hunting the moose, by Captain Butler, who studied them on the Peace River.

“No man save the Indian or the half Indian can hunt the moose with chance of success. I am aware that a host of Englishmen and Canadians will exclaim against this, but nevertheless it is perfectly true. Hunting the moose in summer and winter is one thing; killing him in a snow-yard, or running him down in deep snow is another. The two methods are as widely different as killing a salmon which another man has hooked for you is different from rising, hooking, playing, and gaffing one yourself.

“To hunt the moose requires years of study. Here is the little game which his instinct teaches him. When the early morning has come he begins to think of lying down for the day. He has been feeding on the gray and golden willow tops as he walked leisurely along. His track is marked in the snow or soft clay; he carefully retraces his footsteps, and breaking off suddenly to the leeward side, lies down a gunshot from his feeding track. He knows he must get the wind of any one following his trail.

“In the morning, Twa-poos, or the Three Thumbs, sets forth to look for a moose. He hits the trail and follows it; every now and again he examines the broken willow tops or the hoof-marks. When experience tells him that the moose has been feeding here during the early night, Twa-poos quits the trail, bending away in a deep circle to leeward; stealthily he returns to the trail, and as stealthily bends away again from it. He makes as it were the semicircles of the letter B, supposing the perpendicular line to indicate the trail of the moose. At each return to it he examines attentively the willows, and judges his proximity to the game. At last he is so near that he knows for an absolute certainty that the moose is lying in a thicket a little distance ahead. Now comes the moment of caution. He divests himself of every article of clothing that might cause the slightest noise in the forest, even his mocassins are laid aside, and then, on a pointed toe which a ballet-girl might envy, he goes forward for the last stalk. Every bush is now scrutinized; every thicket examined. See! he stops all at once! You who follow him look, and look in vain; you can see nothing. He laughs to himself, and points to yon willow covert. No, there is nothing there. He noiselessly cocks his gun. You look again and again, but you can see nothing. Then

Twa-poos suddenly stretches out his hand and breaks a little dry twig from an overhanging branch. In an instant right in front, thirty or forty yards away, an immense dark-haired animal rises up from the willows. He gives one look in your direction, and that look is his last. Twa-poos has fired, and the moose is either dead in his thicket or within a hundred yards of it.

"One word now about this sense of hearing possessed by the moose. The most favorable day for hunting is in wild, windy weather, when the dry branches of the forest crack in the gale. Nevertheless, Indians have assured me that, on such days, when they have sighted a moose they have broken a dry stick, and although many branches were waving and cracking in the woods, the animal started at the sound, distinguishing it from the natural noises of the forest."

Sir J. Richardson remarks that in the rutting season the bucks lay aside their timidity and attack every animal that comes in their way, and even conquer their fear of man himself. The hunters then bring them within gunshot by scraping on the blade-bone of a deer, and by whistling, which deceives the male, who blindly hastens to the spot to assail his supposed rival. If the hunter fails in giving it a mortal wound as it approaches he shelters himself from its fury behind a tree. Moose-calling is practised most successfully by the Indians during the still autumn evenings. With a trumpet made of birch bark, eighteen inches long, the low voice of the cow is imitated so as to entice the male nearer, or else the louder call of the male is sounded. The males are in very poor condition for some considerable time after the rut.

Besides feeding on willow tops, the striped maple is a favorite food-tree which has hence been named moose-wood. Young trees are often ridden down to bring the tender shoots within reach. It is said that the Indian word of which moose is an altered form means wood-eater, but bark and various evergreens like *Gaultheria* also afford subsistence to it.

In winter the moose herd together in small troops for mutual protection. Occasionally several such herds unite, and the deep snow may then be trodden down over several acres, forming the moose-yards of the hunters. When the ground is uncovered by snow the moose has a great advantage over the hunter in being able to clear fallen timber and similar obstacles with the greatest ease, thanks to the length of his legs. His high shoulders give him an awkward shuffling gait, accompanied by a peculiar crackling noise of the ankle-joints at every step, which may be heard at some distance. At a more rapid pace the hind legs are straddled so as to avoid tripping up the fore heels, which is not always successful, for the moose was at one time supposed to be liable to epilepsy from this awkwardness in tripping itself.

The old world moose (elk) is said to have the anterior division of the horns less developed than the American form, and to be somewhat paler in its coloring. In Europe it is commonest in Sweden and Russia, and is carefully preserved in the forest of Ibenhorst, in Prussia. The numbers in that preserve diminish, however, from year to year, probably as the result of in-and-in breeding, and the extermination of this noble animal from the more inhabited parts of Europe is likely to be only a question of time.

Lloyd, in his "Scandinavian Adventures," gives some valuable particulars as to the occurrence and mode of hunting of the elk in Norway and Sweden. Once common over all the wooded part of the peninsula, it was in danger of being exterminated until protected by legislative enactments, which enforce a close season from November or December till the end of July. It had formerly a price put on its head, and was

classed with the lynx, bear, etc., as a noxious animal, from its destructiveness to young wood, and from its making free with the stacks of hay and moss, and even with the grain of the peasants. The elk is found within the limits of 58° and 64° north latitude in Scandinavia. It is probably hardy enough to exist north of 64°, but has been exterminated in northern Lapland. It does not wander much, but if undisturbed remains for a long time on the same hillside. Where several travel together they do so in Indian file, and cross the country as the crow flies, deterred by no obstacle.

The food of the elk varies with the season. In summer the shoots of various trees and shrubs are eaten; during the rutting season the *Ledum palustre* has the effect of making him more savage, and in winter the beard-like lichens growing on the pine trees, as well as the leaves of various evergreen trees, afford him sustenance. The branches of the trees are bent down with the head to bring twigs within reach, and even a slender tree may be curved by the weight of the body so as to make the topmost boughs available. The cry during the rutting time is described as a loud report produced by the overhanging upper lip, succeeded by a snort like that of a horse when alarmed, but much louder, and by a note as from a trombone. The male, when it has paired, forms a cavity, or 'grop,' in the ground, which the pair do not desert during the rutting season. Several pairs may be found near one grop, the situation of which is rendered evident by the males scoring the small trees in the vicinity with their horns.

Many fights occur during the rutting season; usually the antlers, but occasionally the hoofs are used. The latter are most efficacious in striking out at dogs or wolves. The conquered males are generally very savage. The period of gestation is about nine months, one to three fawns being dropped in May or June, which stay with their mother till the third year. The mother defends the fawns ferociously. Fawns have been caused to suckle domestic cows with little difficulty when taken away sufficiently early.

An illegal mode of hunting the elk is with the 'elg-grop,' a pit something like that used for securing the caribou in Northern America, but with spikes arranged so as to wound and prevent the escape of the animal. The 'elg-led' consists of a young and pliant aspen, fastened by its thick end horizontally, about four feet from the ground, in notches cut in two upright posts, while its free end is bent sideways, in the manner of a bow, and in this position rests on a rail placed at right angles, where it is secured by a wooden pin. One end of a piece of wire is fastened to this pin, and the other end, after the wire has been drawn across the path, to a post on the other side. An arrow rests on a groove on the rail, and is driven, when the bow is released, with great force into the animal breasting the wire, as the pin which holds the bow in the bent position is thus pulled out. Such elg-leds may, however, secure game for which they were not intended, and several accidents to travellers have caused the prohibition of them in certain districts.

Elks are also driven, most successfully, in winter, in Scandinavia, and are likewise hunted with trained dogs, but most are run down on 'skidor' (replacing the American snow-shoes), especially when the surface of the snow is hard enough to support the skidor but not the elk.

The genus *Hydropotes* has been recently established for a new water deer from China. "It occurs in large numbers in the large riverine islands of the Yangtze, above Chinkiang, living among the tall rushes that are there grown for thatching and other purposes. The rushes are cut down in the spring, and the deer then swim away to the

main shore, and retire to the cover of the hills. In autumn, after the floods, when the rushes are again grown, they return with their young and stay the winter through. They are said to feed on the rush sprouts and coarse grasses, and they doubtless often finish off with a dessert from the sweet-potatoes, cabbages, etc., which the villagers cultivate on the islands during winter. They cannot, however, do much damage to the latter, or they would not be suffered to exist in such numbers as they do; for the islands have their villages, and a pretty numerous agricultural population. Fortunately for the deer the Chinese have an extraordinary dislike for their flesh. I could not ascertain why, but it must be from some strange superstition, as the Celestials are otherwise pretty nearly omnivorous. The deer are killed only for the European markets, and sold at a low price. Their venison is coarse, and without much taste, but is considered tolerable for want of better; it is the only venison procurable in Shanghai." The deer appear to be very prolific, and not to suffer materially in numbers from the European sportsmen. The young are spotted, and number three to six at a birth. There are no antlers in either sex, but the canines are of immense size, curved downwards, and slightly convergent in the male, with non-persistent pulp. To the absence of antlers this water deer owes its specific name, *H. inermis*. The coat is of coarse stiff hair, of chestnut color, deepening above and paling on the under parts. The length of an animal not quite full grown is about thirty inches.

The last of the old world genera, with the same structure of the foot as the new world forms, include the Roe Deer of Europe and Asia, *Capreolus caprea* and *pygargus*. The latter, from the mountains forming the watershed between the Russian and Chinese Empires, is regarded by some naturalists as merely a large variety of the common roe. The European species has a very wide distribution through suitable places in both northern and southern countries, extending to northern Palestine. The antlers are less than twice the length of the head, generally with six tines, the brow-antler projects forwards and upwards from about the middle of the antler. The tail is very short, the stature small, about twenty-seven inches at the shoulder, and the young spotted. The same change of coat, both in color and texture, which has been described in relation to the red deer, is also observed in the roe. It is not so gregarious as the red deer, buck and doe being generally found in a herd, with two or three fawns. The does are tameable, but the bucks only partially so. Like the red deer the roe is very destructive to trees, as it browses on the tender shoots as well as on herbage. It has consequently been extirpated instead of preserved in many forests.

The remaining genera of deer, *Cariacus*, *Pudua*, and *Rangifer*, resemble the moose and roe deer as to the bones of the foot, but differ in the skeleton of the nasal chamber; they are, with the exception of the reindeer, confined to the new world. Almost all the species belong to *Cariacus*, the small Chilian pudu merely forming one species, while the reindeer exhibits in its vast range differences, which by some naturalists are regarded as of specific, by others as of merely "varietal" value.

The genus *Cariacus*, to which our American deer belong, has been divided into various sub-genera, of which *Cariacus* is reserved for the more northern forms. The antlers, of which the pedestals are short, do not greatly exceed the head in length. A short upright brow-antler rises from the inner surface of the lower third of the antler some little distance above the burr. The antlers are curved boldly forward and inward, one or more tines being developed from their convex or posterior surface. There are no upper canine teeth; the molars sometimes have small accessory columns, and the central incisors are but slightly spatulate. A tuft of long hair projects from

the inner surface of the limb at the tarsal joint. The tail is long; the stature medium; and the young spotted.

In most of the species the antlers are not dichotomously branched, and the lachrymal pit is only moderately deep, but in the mule deer of the west and the Columbian deer the reverse obtains. We figure the ordinary American deer (*C. virginianus*), as the type of the former group of species, to which also the white-tailed deer (*C. leucurus*) and the Mexican or Sonora deer (*C. mexicanus*) belong. As elsewhere, in referring to the ruminants of this country, we are largely indebted to Professor Baird's magnificent monograph of the North American Mammalia. The Virginia deer is abundant in various wooded and mountainous parts of the United States and Canada, but it does not occur west of the Missouri river, nor does it extend far north into the British Possessions. It, however, ranges south to Texas, where it does not attain the size of the more northerly specimens. Drs. Coues and Yarrow have recently described a very small variety from Arizona, weighing only some seventy pounds.

The general color of the summer coat on the back and sides is a light chestnut red, but the buttocks, the lower part of the side, the side of the head, and the throat and chest are more cinnamon-colored. The under parts are white, as is also the under surface and edges of the tail. The upper surface of the tail, on the contrary, is reddish, darker near the tip. The ears are scarcely more than half the length of the tail, white on the inside, sooty brown on the convex surface. Under the chin is a transverse band of black, and behind this is one of cinnamon color. The winter coat is grayer, and at the time when this is assumed the deer is said to be 'in the blue.' The antlers may attain in an old buck as many as six or seven points, but the age after six years, when five points are attained, is reckoned more by the size and thickness of the antlers than by the number of points.

The buck sheds his antlers from January to March, earlier in the southern than in the northern states. At this time he retires into thick bush, but emerges to lead a less solitary and more peaceful life with his comrades. The rutting season is in October and November, earlier in the southern states, and the doe drops her two or three young in May or June. Young does calve later than older animals, and have generally only one fawn.

As with other members of the family the food of the Virginia deer varies with the season. In the autumn and winter their food consists largely of buds, tender shoots, ferns, bark, etc.; but in summer rich herbage and pond lilies are sought after. The



FIG. 147. — *Cervus virginianus*, Virginia deer.

latter appear to be specially enjoyed while the animal is seeking in some pond or quiet river a temporary respite from the annoying flies. Water is a necessity to the deer. They leave the hill on their way to the water generally before sunset, so that the hunter has then one of his opportunities of meeting with the game.

Various methods of hunting are resorted to, sportsmanlike and unsportsmanlike. Stalking is of course the most difficult, and affords the best sport; but in many places the deer are driven by dogs along particular tracks where the guns are stationed at intervals; or they are hounded into water, or shot from scaffoldings erected near deer paths, fences being employed to confine the deer to the paths. In some lake-districts hunting with a light at the boat's head is practised, the shots so obtained, however, being somewhat uncertain. Curiosity appears to be as marked in the Virginia deer as in many others of the family.

The White-tailed Deer (*C. leucurus*) is of similar stature to the Virginia deer, but replaces that species in the western parts of Dakota and Nebraska, and in Northern California, Oregon, and Washington, where it is most abundant on the eastern slope of the Cascade Mountains. The tail is considerably longer than in the allied species, and is merely reddish above and not of dark color near the tip; the chin also is entirely white, the fur finer, its hues paler throughout, but with dusky waves, the legs slenderer and the hoofs narrower and longer.

Lord Walsingham found this species abundant about the source of the Deschuttes river, where the specimens are finer than those met with further north. "They appear to frequent the thick willow-clumps and other brushwood bordering streams and swamps. They are extremely difficult to distinguish among the foliage, and remarkably quick when alarmed. As they bound off over logs and fallen trees, or dash through the thicket, they have a habit of swinging their broad white tails with a conspicuous flourish, which becomes annoying to a sportsman, to whom they never afford anything but a snap shot, which is very apt to fail." In these regions *C. leucurus* is met with in the valleys, while the mule deer frequents the hills, and the prong-buck the open plains. All appear to migrate, according to the season, to summer or winter quarters, the distance between these varying with the severity of the season.

The Mexican or Sonora Deer (*C. mexicanus*) differs from the foregoing species in its small size, in which respect it accords with the general law recognized by Mr. Allen, that in the case of animals the centre of whose area of distribution is in North America size steadily decreases as we go southwards. This is even the case with individuals of the species under consideration, for the Texan specimens are much larger than those from Central America. The coat of this species does not alter with the seasons, and is remarkable for its ashy or grayish brown hues resembling the winter coat of the Virginia deer. The tail is very short, and the hoofs short and broad—peculiarities which distinguish it from the last species, with which however it agrees in the absence of the marked dark band across the chin. The sub-genus *Cariacus* also extends into Central and South America, with various other species, the habits and peculiarities of which are not very well known.

The Mule Deer and the Columbian Deer (*C. macrotis* and *C. columbianus*) differ from the above-mentioned species in having dichotomous antlers. The former in its geographical distribution resembles *C. leucurus* (being especially common in the Blue Mountains of Washington Territory, Oregon, and Idaho), but differs from it not only in its greater size and the form of the antlers, but also by its coloring and the length of its ears, to which it owes both its familiar and its specific name.

The coat is ashy brown, changing to gray in winter, with yellowish legs, but a dorsal black stripe persists which is very characteristic and is said by some observers to be erectile. The ears stand some eight inches from the head, and are well covered with hair, which along the margins is of a sooty hue. The tail is slender and cylindrical, not much longer than the ears, naked beneath but terminated by a black tuft. The buttocks are white, and the gland of the hind leg very large.

According to Prince Maximilian, the gait of the mule deer is not so rapid as that of the Virginia deer; it carries its tail erect and still, in this respect unlike *C. leucurus*.



FIG. 148. — *Cariacus macrotis*, mule deer.

They rut in October, cast their horns in March. Usually only one fawn is dropped, of pale yellowish hue with white spots. The young are dropped in May and June. After the rainy season they return to the mountain slopes which they ascend to different altitudes, according to the severity of the season.

The mule deer are thus characteristically mountain and plateau loving forms; they have frequently to be stalked over very rough ground, but the hunter is repaid by the venison, which is far superior to that of the white-tailed deer. A variety has recently been described by Judge Caton from southern California and Arizona, smaller, redder, and with a distinct, dorsal, black line on the tail. It appears to be especially common in the coast range of southern California and is not found east of the Sierras.

The Black-tailed Deer (*C. columbianus*) is about one third smaller than the mule deer, and similar in stature to the Virginia deer. The tail is cylindrical, hairy and white beneath, but black above. There is no surrounding white patch on the buttocks, but there is a dusky horseshoe mark on the forehead in front of the eyes, all of which peculiarities serve to distinguish it from the mule deer. This deer is occasionally found on the same ground with the mule deer, but is abundant throughout California, and further northward appears to be restricted to the western slopes of the Cascade Mountains. According to Hallock its favorite haunts are the dense forests of redwood which clothe the mountains of Oregon and California. Further south it frequents the impenetrable thickets of chapparal and manzanita, and takes to these when wounded. Its venison is poor eating.

The following results as to attempted domestication of American antelope and deer are from a communication by Judge Caton, and may be conveniently recorded here. He is satisfied that Columbia deer cannot be successfully domesticated in his grounds. They either find something which does not agree with them, or something is wanting which they require—most probably the former. All experiments with ruminants whose natural habitation is confined to the United States west of the Missouri River have proved failures. The mule deer, prong-horn, and mountain sheep all die shortly after their confinement from diarrhœa, which although checked returns obstinately. The elks do well, and are very prolific; of all the Cervidæ they seem the best adapted to domestication. The Virginia deer are vigorous and healthy but not prolific. They have been successfully hybridized with small deer of a tropical species—the Ceylon deer and the Acapulco deer. These prove to be very hardy, a circumstance which agrees well with the success which the introduction of the Japanese deer (*C. sika*) has met with in deer parks (especially Viscount Powerscourt's) in Great Britain.

The sub-genus *Blastocerus* includes *C. pahudus* and *C. campestris* from Brazil and Paraguay. The former is a marsh-loving form, the latter delights in open countries, and runs with frequent bounds. In stature it approaches the roebuck, has a short tail and a reddish brown coat. The dichotomous antlers slightly exceed the head in length. The posterior branch is stronger than the anterior, the former being always bifurcated in adults, the latter generally so.

The South American forms, *C. chilensis* and *C. antisiensis*, are from Chili and the Peruvian Andes respectively. They constitute the sub-genus *Furcifer*, the name being derived from the forked antlers, which have a simple beam, and a strong, upwardly-projecting brow-antler.

Some further South American species, of small stature, heavy form, and arched back, with simple spike-like antlers not exceeding half the length of the head, are united under the sub-genus *Coassus* (= *Subulo*). *C. rufus* is a red-coated form standing about twenty-seven inches at the shoulder; *C. simplicicornis* (the Catigneiro, literally "Stinker") of smaller stature, and brown; *C. rufinus* and *nemorivagus*, the former red, the latter gray, both only nineteen inches at the shoulder.

The Chilian Andes harbor the only representative of the genus *Pudua* (*P. humilis*), the Pudu, a pigmy form with simple spine-like antlers only two and a half inches in length. Nothing is known of the habits of this deer, which is the smallest in stature of the Cervidæ.

The last genus of the Cervidæ is *Rangifer*, including the reindeer of the old world and the caribou of the new. It is to some extent uncertain what influence climate has had in the determination of the differences between these forms. Two well-

marked varieties occur in America, the woodland caribou and the barren-ground caribou, and both these and the old world reindeer are frequently regarded as distinct species. All agree in the following particulars. Antlers are developed in both sexes; a strong brow antler is developed sometimes on both, but more frequently on only one antler, that on the other being a mere rudiment. The brow antler, when fully developed, is directed downwards parallel with the face, and palmated anteriorly. A short distance above the brow antler another similar tine is developed. Above this the antler forms a bold curve concave forwards; its extremity is palmated, and a short tine is developed from its posterior surface at half its length. There is no naked spot on



FIG. 149. — *Cervus campestris*, Pampas deer.

the end of the muzzle; the hair is coarse, longer and paler in winter, forming a mane on the throat. The young are unspotted, and the ears and tail are short.

The natural history of the old world reindeer is better known than that of the caribou. In size the Reindeer (*Rangifer tarandus*) approaches the red deer but does not attain its stature, for the legs are considerably shorter, a circumstance which accounts for the less graceful carriage of this species. The hoofs are widely separated, the dew-claws almost reach the ground, and the wild forms are readily distinguishable from the domesticated animals by the clumsy breadth of hoof in the latter, associated with a general additional ungainliness in their carriage.

The coat is thick, formed of long bristly hair, which is only less bristly where it attains its greatest length and forms a mane on the throat. In winter it measures an

inch and a half in thickness, and is decidedly grayer than the summer coat. The tame animal is darker on the upper parts during the summer than the wild, but this dark hue usually gives place to gray in winter time. The wild animal occurs in mountainous districts of Scandinavia, Lapland, Finland, Siberia, and Greenland; it inhabits there the barren plateaus, "fjelds," which are so common in the northern range of mountains. They generally avoid wooded tracts, although in Siberia they are found to migrate for protection from the cold of the plains to the wooded district which they desert again when the flies become troublesome. Such migrations are effected in large herds of two



FIG. 150. — *Rangifer tarandus*, reindeer.

or three hundred. The reindeer is decidedly more gregarious than the other forms of *Cervidæ*, and it is rare even to meet with a solitary male.

The usual gait is a rapid trot accompanied with a peculiar crackling of the ankle joints similar to that in the moose. For swampy grounds the widely spread hoofs are of the greatest service, and the same conformation enables the animal to walk on the snow whenever the surface is at all hardened. The food is composed of various herbs, shoots, and buds of a few trees, and in winter the fore-feet are used to dig up the reindeer lichens on which they then are almost entirely dependent. The horns are cast in December, and the rutting time takes place in September when the horns are again fully formed. The female drops a single fawn in April, and thereafter a separa-

tion into small herds of male, female, and calf takes place, while larger herds of the young males and females are led by an old female.

The senses of the reindeer are so sharp that stalking is extremely difficult; the pursuit is further heightened in difficulty by the protective coloring of the coat, which has been observed also of both woodland and barren-ground caribou. In Siberia many tribes are dependent for their yearly supply of animal food on the reindeer, which they slay in great numbers in their spring and autumn migrations, seizing their opportunity while the vast herds are swimming the rivers — a method which is, however, not free from danger.

Man is not the only enemy of the reindeer. Various Carnivora are always on their tracks; but perhaps their most persistent enemies are the flies of the northern regions, which plague them during the whole summer. The gadfly (*Æstrus tarandi*) not only pierces the skin but lays its eggs there, where the larvæ afterwards live in the abscesses thus brought about; and a botfly (*Æstrus nasalis*) penetrates the nasal cavities, oviposits there, and the larvæ, after causing great annoyance, are finally voided through the nostrils.

The inhabitants of Lapland and Finland, as well as many tribes of northern Siberia, have from time immemorial kept the reindeer as a domesticated animal. The Koreki have herds of forty or fifty thousand; the Laplanders, however, have rarely more than five hundred. The latter migrate with their herds, giving them most freedom in September, the breeding time, when the stock is improved by the admixture of wild elements. Just before that is the usual slaughter time, as the flesh, especially of the males, acquires an unpleasant flavor at the time of the rut. The animals serve not only as food, but the hide, horns, and sinews are all converted into useful articles of clothing, or implements of various kinds. The rich cream-like milk obtained with some difficulty from the animals is made during the summer months into small cheeses — an important food article with these northern people.

It is chiefly in Lapland and Norway that the reindeer is used as a draught beast, and then they are only required to pull light, boat-like sledges over the snow. In Kamchatka, however, they are saddled and ridden by the natives, a pad over the withers serving as a saddle, and a long staff acting as a substitute for the stirrup in mounting. Pack-saddles carrying from seventy-five to one hundred pounds are also placed on the shoulders. The Tungus have very often a train of some six or twelve reindeer acting as beasts of burden, one animal's halter being fastened to the animal in front of it.

According to Mr. Lloyd, it is met with in Norway as far down as 59° north latitude; in Sweden 62° may be considered its southward limit. Nilsson, describing their abundance on the fjälls in the early part of this century, states that occasionally herds covering three and a half miles in width, and packed as close as sheep, used to be seen. The food in summer is somewhat more varied than in winter when it is almost confined to the reindeer moss, for then various species of dock (*Rumex*), of buttercups (*Ranunculus glacialis*), of willowherb, buckbean, and horse-tails serve to afford them sustenance. In the rutting season each old male has a pretty large harem, which he has trouble enough to keep together, for the hinds constantly tend to stray out of his reach: When two herds meet, each headed by a buck, a battle royal takes place, the victor adding the harem of his opponent to his own herd.

The period of gestation is about eight months; the young, usually single, are dropped in May or June, very often on a snow drift. In addition to the methods of

hunting detailed in the description of the elk, the reindeer is often snared in the early part of the autumn when he resorts to wooded districts. A fence is erected with openings at intervals, in which suitable nooses are arranged, connected with halters which secure the deer till the hunter arrives. Pitfalls were also formerly much employed.

Two kinds of tame reindeer are recognized, the mountain form and the forest form. The latter are pastured all the year round in the forests, and are much larger than the former, though not so large as the wild animal. The small size of the tame reindeer is to be accounted for by the fawns being robbed of part of their natural nourishment by the Lapps.

"When the deer are about to be milked the herd is driven into a small enclosure, rudely fenced with boughs, in the immediate vicinity of the encampment. In this enclosure are several fires, damped with wet moss, the smoke from which tends, in a degree, to keep away the mosquitos. The poor creatures seem fully sensible of the beneficial effects of the smoke in ridding them of their tormentors, for one sees them nestling, as it were, almost into the very fire itself. The deer seem rather averse to being milked, and it is only by force that they are made to submit to the operation. Men, as well as women, officiate on these occasions, each being provided with a long, pliant leathern thong, furnished at its extremity with a running-noose, which, lasso fashion, they throw over the antlers of the individual singled out, and with so much dexterity as rarely to miss the mark. During the short time the animal is milking, the thong is either held by one of the women or made fast to a birch shrub, several of the thickest having been stripped of their leaves, and left standing for this purpose. Some of the deer are very refractory, frequently even throwing down the women and butting at them with their horns, for which, however, they care little. But strong as the Lapps are they appear to have little power over the deer, for when it has the lasso about its horns, and refuses to be milked, it will drag the holder with ease around the fold.

"The quantity of milk given by the reindeer is, perhaps, less than half a pint. The flavor is highly aromatic, owing, probably, to the kind of herbage the animal browses upon in summer. In color and consistency it resembles very rich cream, and its nature is such that, however gratifying to the taste, it is difficult, and even unwholesome, to drink in more than small quantities. In rare instances the milk is converted into butter, which is white and hard. It is more suitable for making cheese, of which it is said to produce from six to ten times more than the same quantity of cow's milk. But though the quantity may be great, the quality of the cheese is certainly not much to boast of.

"It is for the most part during autumn, when the reindeer are in the best condition, that the Lapp slaughters such of them as he or his family may require for food during the coming winter. The axe is seldom or never brought into use on these occasions. It is with the knife alone that the deer is slain, as well as quartered. The weapon is driven into the nape of the neck, which at once brings him senseless to the ground, on which the man sticks him in the breast, so in a very few moments life is extinct. The meat is stored away in a sort of larder, for future use. Though exceedingly palatable, it is, by all accounts, greatly inferior to the venison of the wild reindeer."

The Woodland Caribou (*Rangifer caribou*) most nearly resembles the reindeer in structure, but is separated geographically from that species by the barren-ground caribou, which is decidedly different from the old world form. Richardson says that

the proper country of this deer is a well-wooded strip of low primitive rocks, a hundred miles in width, which extends from Athabaska Lake to Lake Superior, about one hundred miles south of Hudson's Bay. It, however, extends southward into Canada, and formerly into the northern States; it is of course only common in thinly settled districts, for its gregarious habits make it an easy victim to extirpation. In certain easily accessible parts of the British possessions, however, the caribou is still fairly common. At one time they were abundant in Labrador, but Professor Hind attributes their present scarcity to the greater ease with which the Indians have destroyed them since they became possessed of powder and shot. Excellent caribou hunting is still to be had in the Provinces of Quebec and New Brunswick, where proper game regulations enforce a close season from February to August. They are found also in large herds in the interior of Newfoundland, where, however, their numbers have been diminished by wolves.

The general color of the woodland caribou is dun gray, well calculated to protect it, owing to its similarity to the tone of the lichen-clad trees of its native woods. The outer surface of the legs and shoulders, as well as the nose and ears, are brownish, but the under parts are generally white, and a band of white surrounds the legs, adjoining the hoofs. An average specimen stands forty-two inches high at the shoulder, measures seventy-two inches to the root of the tail, while the tail itself, with its hairs, measures another six or seven inches. As in other deer the winter coloring is somewhat different from the summer's, and here we observe, that in the caribou the increase in the white of the coat is such as to be as good a protection in winter as it is in summer.

The woodland caribou migrates in summer to avoid the flies. Those that are found furthest north seek the coast in the neighborhood of James's Bay in the summer, returning north to their more inland woods in September. But as a rule they are found further to the south in winter than in summer. So in Newfoundland they migrate from the southeast of the island in the winter to the northwest in summer, and in Labrador they are found nearer the water in summer than in winter. October and April are the months in which these migrations take place; the travelling is done at night, the lead being taken in turn by animals which fall to the rear when exhausted by the process of reconnoitring. They are frequently killed in large numbers on these migrations, especially while swimming large rivers which may lie across their track, like the Nelson and Severn. In Newfoundland the Indians of bygone times erected a complicated system of fences, made of felled trees, with apertures here and there round which the hunters were stationed. It is found that tracks in the course of which they have been much persecuted are shunned.

The food of the caribou in winter is almost exclusively the caribou moss (*Cladonia rangiferina*), but various other lichens found on trees are eaten. Young shoots, buds, and flowers, of various sorts, serve as food in summer.

The hunt of the caribou is at its best in December. Reference has already been made to the wholesale methods of slaughter adopted during the fall and spring migrations, but the stalking in winter has more of the elements of sport. When pursued the caribou keeps the head down, the antlers back, and the body as low to the ground as possible. Hunters often follow for several days, ascending trees or the highest peaks to observe the direction the game is taking. A white dress is of much service in stalking, and the minutest attention to the track in the snow, or, if earlier in the year, to the footprints left in the caribou-moss, is necessary. Very often the caribou

makes for the nearest swamp, keeping to its margin, and occasionally taking to the water and making for terra firma again. When it gets on to smooth ice, pursuit is almost useless, as its progress there is very rapid, composed of alternate runs and involuntary slides on the haunches. Brought to bay the caribou loses its timidity, and has to be cautiously approached by the hunters. The flesh of the woodland caribou is not reckoned so good eating as that of the variety from the northern barrens; the skins, however, are much valued.

Professor Hind relates a curious custom of the Indians of the Rivers Moisie and Mingan, in Labrador, who depended largely for their subsistence on the caribou. A doe is reserved out of the first batch of deer killed going inland, the antlers of which are placed by the Indians on the ice of some inland lake before they return to the coast in spring. On the breaking up of the ice the skull and antlers sink, and are thus saved from the teeth of wolves and other Carnivora. This is probably the relic of some religious ceremony.

The Barren-ground Caribou (*Rangifer greenlandicus*) is much smaller than the woodland variety, a buck weighing about one hundred pounds when cleaned. The antlers are, however, larger and more branched, in spite of the smaller size. This species is found in the barren lands of British North America, north of the Churchill River and east of Great Slave, Athabaska, and Deer lakes; from these tracts it stretches also into Greenland. It migrates northwards to the shores of the Arctic Ocean in May, the female reaching the coast (where they drop their young) somewhat earlier than the males. Both this journey and the return, in September, to the inland woods between the 63° and 66°, are undertaken while the ground is largely covered with snow. Their food differs much at these two seasons, for at the sea-coast they are chiefly dependent upon sedges and grasses, while in the woods they eat the lichens growing from the trees in the winter, and where the snow is sufficiently soft those with which the ground is carpeted. The rut takes place in September, the bucks losing their horns in November, while the does retain theirs till the young are dropped.

The summer coat is reddish-brown on the upper parts, and white below, while the winter coat is much closer and whiter. In spring, when the gad-flies begin to trouble the deer, the outer colored points of the hairs are rubbed off, so that the coat is then almost completely white. The skins form excellent clothing, and the leather is used for tents, nets, etc. The flesh of animals in good condition is much esteemed, and the fat on the rump (*depouillé* of the Canadian *voyageurs*) is regarded as a particular delicacy. Both are preserved for consumption as pemmican. The barren-ground caribou is much easier to approach than the woodland species; the Eskimo and Dog Rib Indians being celebrated for the stratagems by which they are enabled to get to close quarters. Many are also killed in crossing the rivers, in deer-traps, formed of snow, and in fenced-in pounds, where they are either shot, or snared by leather nooses suspended from the trees.

In this place we may consider the Musk Deer (*Moschus moschiferus*) which, although unquestionably more closely related to the Cervidæ, and specially to the telemetacarpal forms, than to any other ruminants, nevertheless occupies a somewhat isolated position. Some naturalists form for it a distinct family (Moschidæ), but Professor Flower has recently pointed out that its peculiarities have many points of contact with various members of the deer family, and are not of such importance as those which separate the Cervidæ from the Bovidæ. He regards it as a "low and little-specialized form, an undeveloped deer; an animal which in most points has

ceased to progress with the rest of the group, while in some few it has taken a special line of advance of its own." An account of its appearance and habits may serve to introduce the description of its peculiar anatomical features.

A native of the higher levels of the mountainous districts of Central Asia from the Amoor and Peking to the Himalayas and Siamese mountains, the musk deer has long been known as the source of the odorous secretion to which it owes its name. Its anatomy was first described a century ago by Pallas, and about the same time a living male was brought to Paris. Since then little has been added to our knowledge of its structure till a few years ago a live female was presented to the Zoological gardens, London, but shortly died, and gave to Professor Flower the opportunity to further enlighten us on the subject. The Prince of Wales on his return from India brought two males with him from Nepaul, one of which died shortly after its arrival in England. The musk deer attains the size of a small roe, measuring about three feet

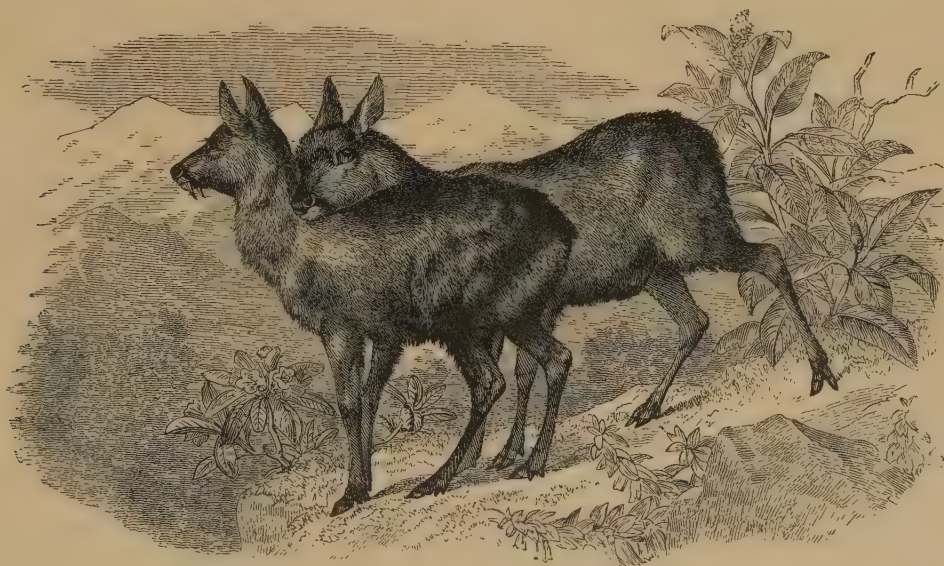


FIG. 151. — *Moschus moschiferus*, musk deer.

in length, and some twenty inches high at the shoulder. The male is somewhat larger than the female, and both are extremely variable in their coloring. The hair is close and sleek, its color generally dirty or reddish brown above and whitish on the belly. The adults are rarely spotted, but the young, as is generally the case with the Cervidæ, always so. A glance at the figure will show the following additional particulars. Both sexes are devoid of antlers; the outer and inner (second and fifth) toes on both fore and hind feet are very long, and all of the toes are capable of wide separation, a feature which must be of great service to an animal which delights in resorts as precipitous as does the chamois. The back slopes upward toward the tail, which is very short. The canine teeth of the male, the roots of which only stop growing in old individuals, are greatly developed, projecting downwards and inwards, and strongly curved on the anterior surface. These are its weapons of offence and defence at the time of the rut, and males shot at this time are very generally found to be scarred by them. It is interesting to note that in an allied form like *Hydropotes*, and a widely

separate form like *Tragulus*, as well as in many other artiodactyles, the absence of horns should be compensated by the tusk-like development of the canines. The male is further distinguished from the female by the possession of certain cutaneous glands, which are situated on the outside of the thighs near the tail, and on the belly behind the navel. It is that in the last situation which secretes the famous musk, a substance which in the recent condition is said to be so strong as to almost overpower the hunters who extract it. The gland is a bag-like fold of skin the wall of which contains the secreting follicles. In adults the bag may hold an ounce or more of the secretion. The portion of skin containing the bags are cut out and dried, during which process much of the rankness of the odor disappears. The Chinese is the best musk, costing from seven to nine dollars, while that from Siberia is of much less value. The difference in the strength of the musk is attributed to the absence of aromatic plants in the food of the creature. The deer are so shy that they are rarely to be stalked; they are captured by traps, from which they are frequently eaten out by weasels, etc. According to Brehm the Tungus attract the adult by imitating the bleating of the young.

The young, to the number of one or two, are cast about May, some six months after the rutting-time. They remain with the mother till the rutting-time of the following year, when the adults collect again, and the young are left to care for themselves.

Also to be regarded anatomically as aberrant deer, the Giraffes (forming a single species, *Camelopardalis giraffa*) have, nevertheless, sufficient peculiarities to necessitate their being placed in a family, CAMELOPARDIDÆ, by themselves. Illiger called the family Devesa, on account of the extraordinarily long neck, which is carried so high that a continuous downward slope results over the shoulders to the tail. In stature the giraffe is the tallest of quadrupeds, the adult male standing twelve feet high at the shoulder, and eighteen at the crown of the head, while the extreme length is twenty feet. The legs are long and slender, terminating in a divided hoof from ten to twelve inches in length, pointed in front; there are neither dew-claws nor interdigital glands. The head is of comparatively small size, but is long, and tapers to the pointed snout, which is entire and hairy; the tongue is correspondingly long and pointed. Both sexes bear horns resembling the pedicels of deer's horns, but about eight inches long and always covered with hair, which forms a black pencilled tuft at the extremity. In front of these is a third bony protuberance in the middle line above the eyes. The white ears are of considerable size and pointed. The tail is upwards of thirty inches in length, and terminates in a tuft of bristly black hair of similar length. The coat in the male is of dark sienna color, varying to black in older specimens, with angular ferruginous spots, darker in the centre, variously disposed over the body. The belly and cheeks are white with dark blotches, and a scanty, upright, rufous mane extends along the middle line of the whole neck. The female, somewhat smaller in size and paler in color, has an udder with four teats. There are no incisors or canine teeth in the upper jaw. In spite of its great length the neck has only the usual number of vertebræ, and the spines of the dorsal vertebræ are particularly high, serving for the attachment of the ligaments and muscles which support and move the head and neck.

The giraffe is never found south of the Orange River. It is still common in equatorial Africa and Abyssinia, and most so in the Fly country, where they are safe from pursuit on horseback at any rate. They are themselves teased by the flies,



Camelopardalis giraffa, giraffe.

but are partly relieved of these by the friendly offices of certain birds. For the following account of their appearance in their native wilds we are indebted to Sir S. Baker's "Albert Nyanza." "There is no animal in nature so picturesque in his native haunts as the giraffe. His food consists of the leaves of trees, some qualities forming special attractions, especially the varieties of the mimosa, which being low permit an extensive view to his telescopic eyes. He has a great objection to high forests. His immense height gives him a peculiar advantage, as he can command an extraordinary range of vision, and thereby be warned against his enemies, man and the lion. No animal is more difficult to stalk, and the most certain method of hunting is that pursued by the Hamran Arabs on the frontiers of Abyssinia, who ride him down and hamstring him with the broadsword at full gallop. A good horse is required, as although the gait of a giraffe appears excessively awkward from the fact of his moving the fore and hind legs of one side simultaneously, he attains a great pace owing to the length of his stride, and his bounding trot is more than a match for any but a superior horse. The hoof is as beautifully proportioned as that of the smallest gazelle, and his lengthy legs and short back give him every advantage for speed and endurance. There is a rule to be observed in hunting the giraffe on horseback—the instant he starts he must be pressed; it is the speed that tells upon him, and the spurs must be at work at the very commencement of the hunt, and the horse pressed along at his best pace; it must be a race at top speed from the start, but should the giraffe be allowed the slightest advantage for the first five minutes the race will be against the horse."

The flesh of the giraffe is said to form very fine eating, rather like veal in Schweinfurth's opinion, although, as Harris observes, it is strong-tasted at certain seasons when their favorite mimosas are in blossom. The skins are used for sandals and for reins.

Within recent years giraffes have not been unfrequent in zoological collections, and have even given birth to young which have been successfully suckled by cows. The pairing season is in March; the single calf is born fourteen months later.

The last family, the BOVIDÆ, is the most rich in genera and species of the Ungulata. They are generally spoken of as the hollow-horned ruminants (Cavicornia), and although the extreme forms, such as the oxen and sheep, appear to be separated by such a wide gap, yet intermediate forms are known, which makes the division into smaller groups a matter of great difficulty. In all except the prong-horned antelope the horns are persistent and usually present in both sexes. They surround, in a sheath-like manner, bony processes of the frontal bones, into which the frontal sinuses may be prolonged as in oxen and sheep, and are formed of horny fibres closely agglutinated together. Incisors and canine teeth are only present in the lower jaw. There are usually dew-claws.

We propose here to adopt the arrangement of the sub-families which Wallace gives in his "Geographical Distribution of Animals," and of which Sir V. Brooke, to whom we so frequently have to refer as an authority on the ruminants, is the author.

The first sub-family, Bovinæ, embraces our domestic cattle, the bison of the old and new world, the wild and domestic races of Indian cattle, the yak, and the old world buffaloes. All are of large size, the horns being bent outwardly, and round at least at the points. There are no sub-orbital nor interdigital glands. The point of the snout (muffle) is naked, and the upper lip not furrowed. The molar teeth have accessory columns of enamel between the crescentic folds. The legs are only moderately long, and there are four teats.

In the first genus, *Bos*, to which our domestic cattle belong, the forehead is long and flat, and the horns not thickened at their origin. Our domestic cattle, generally spoken of as belonging to one species, *Bos taurus*, are really local races due to artificial selection, and probably descendants of various wild species now extinct. Most of these are only known by fossil remains, but one of them at least existed down to comparatively recent times. Before discussing the races existing at the present day it may be well to refer to these extinct forms.

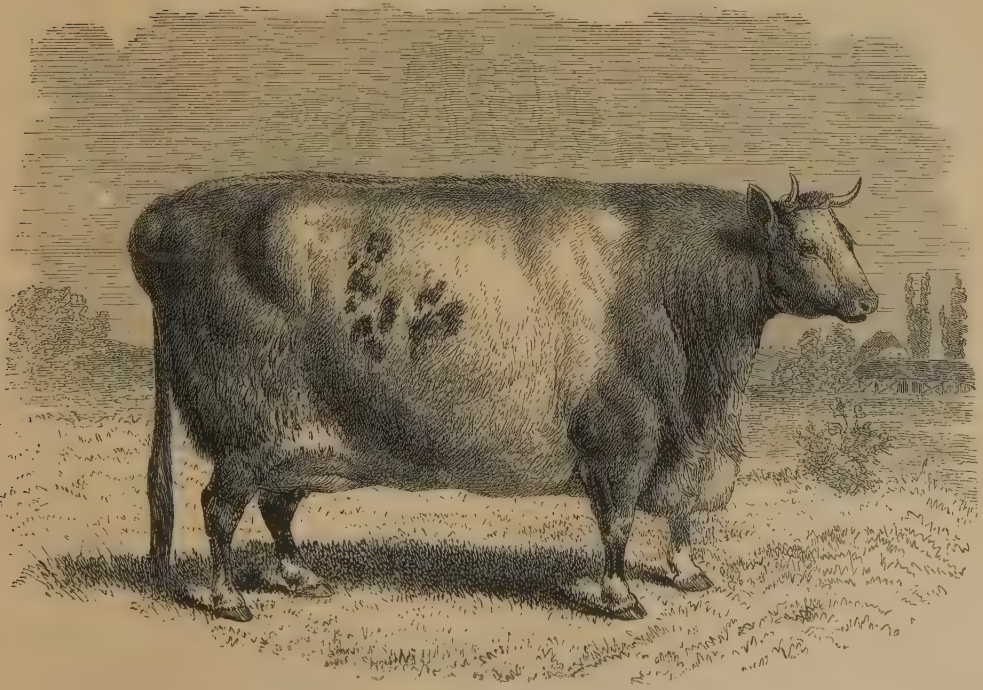
Although Pallas, Bojanus, and other naturalists expressed the opinion that only one sort of wild cattle has existed during historical times in Europe (the bison, *Bison europæus* [Polish Zubr], which is still preserved in the forest of Bialowieza and is found wild in the Caucasus), it is beyond doubt that a second species (*Bos primigenius*) [the Urus, Ur of the Niebelungenlied, Polish Tur], occurred, and was only exterminated in Poland little more than two and a half centuries ago. Professor Wrzesniowski has recently undertaken a study of the records which bear on the co-existence of these two forms, from which these particulars are extracted. Rüttemeyer has shown that in prehistoric times four forms of ox co-existed in Europe, viz., *Bos primigenius*, *B. trochoceros*, *B. frontosus*, and *B. longifrons*. Of these the first and last were probably alone wild forms, the second and third being domesticated forms, progenitors of certain existing races. Of these wild oxen it is to the long-horned species, *Bos primigenius*, that the records point as having lived within historical times in Poland, and this conclusion is rendered the more likely by the discovery of remains of the same species in a bed of turf in Scandinavia which would hardly require more than a thousand years for its formation. Sigmund von Herberstein, in an account of a journey to Poland (1571), gives figures of the tur and zubr side by side, which indicate unquestionably their zoological characters. In prehistoric times the tur had a wide range, its bones having been found from England to Italy and to Siberia. Later it appears to have been restricted to certain British forests and to central and east Europe. By the thirteenth century it was necessary to protect it and the bison, in the latter localities, from extermination by restricting their hunt to the Dukes of Masowia. In the sixteenth century the tur was only found in the Jaktorówka, and was there preserved much in the same way as the bison is to-day in Bialowieza. The last Polish tur appears to have died in 1627.

It has been suggested that the tur was only a hybrid between a male bison and a domestic cow, and certain experiments were undertaken in the forest of Bialowieza with the view of determining this point. The results, however, pointed to the predominancy of the bison's characteristics in the hybrid offspring. Young calves of *B. priscus* were without difficulty caused to suck domestic cows approaching the bison in color, although older ones refused to do so. Each bison calf required two cows as wet-nurses, as the milk of one was not sufficient.

With some modifications the primitive wild cattle of the British Islands are preserved to the present day in certain forests; but although still wild they are very easily domesticated when taken sufficiently young. Those in the park of Chillingham approach most nearly to the primitive type, but have lost almost entirely the characteristic mane; a ridge of coarse hairs on the neck is its sole representative. Their habits are those of wild animals; the bulls fight for supremacy, and the females conceal their calves in thickets, merely returning to suckle them several times a day. The color is pure white, but the ears are red, the muzzle brown, and the tips of the horns black. Similar cattle existed in Wales, and still form part of the domesticated stock



Bos taurus, var. *hollandicus*, Dutch cow.



Bos taurus, var. *dunelmensis*, Durham cow.

in the County of Pembroke. Also in various parts of Scotland they persisted till the middle of the sixteenth century, but are now only preserved in the Duke of Hamilton's park at Cadzow. The breeds of the Highlands of Scotland are of small size, covered thickly with hair, hardy, and well adapted to the mountainous tracts on which they are bred; they resemble cattle occurring in similar situations in Shetland and Wales. Of the forty or fifty independent breeds of cattle described we figure three: the Swiss cow (*Bos taurus*, var. *friburgensis*), the Dutch cow (*B. taurus*, var. *hollandicus*), and the Durham cow (*B. taurus*, var. *dunelmensis*). The first of these is probably the lineal descendant of the extinct *Bos longifrons*, the second is regarded as descended from *Bos primigenius*, while the third is a product of the most careful artificial selection, the object of which is the establishment of peculiarities favoring the fattening of

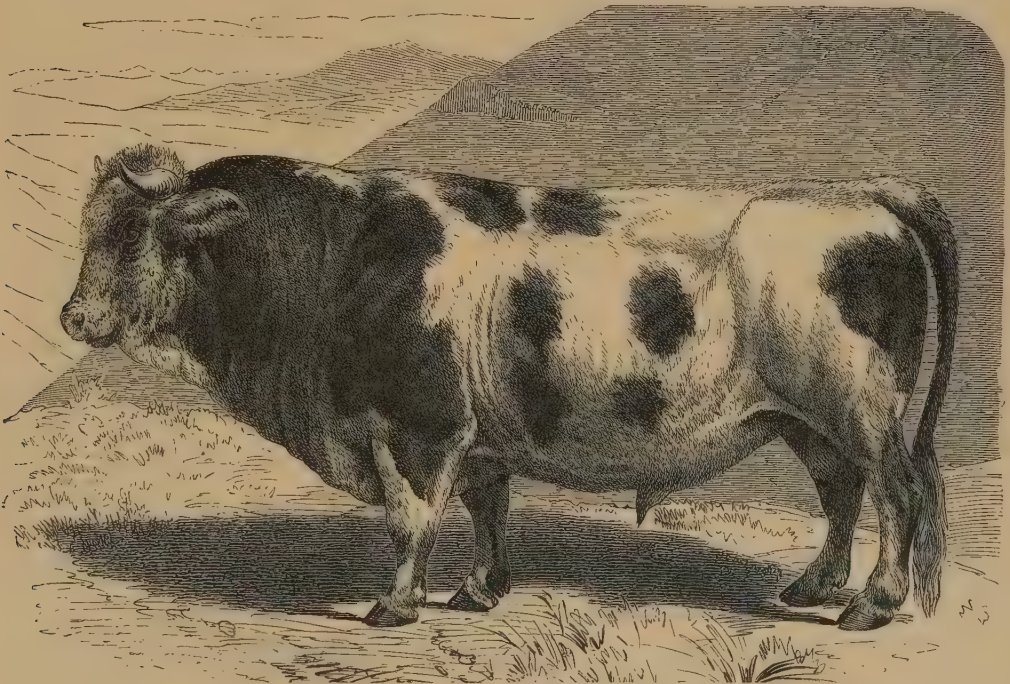


FIG. 152. — *Bos taurus*, var. *friburgensis*, Swiss bull.

the ox. So adapted is this short-horned breed for this purpose that it bids fair to supersede in time all other breeds, or at any rate to greatly modify them.

Cattle which have been subjected to domestication readily become wild under suitable circumstances, and consequently we find in many countries half-wild cattle frequently in large herds. The cattle of South America, introduced in small numbers by the Spaniards upwards of three centuries ago, now extend in immense herds over the fertile plains of Paraguay, Buenos Ayres, etc. In the Maremma of Italy and in various parts of Spain and Portugal the cattle lead a similar free life, taken care of by herdsmen who drive them as required into the towns for slaughter, or assist in the capture of the wildest bulls for the national sport of the Spaniards.

The European Bison (*Bison europæus*), to which we have made reference above, constitutes with the American bison or buffalo the sub-genus *Bison*. This sub-genus is distinguished from *Bos* by the forehead being broader than it is long, and

by the position of the small, round, upwardly-curved horns which spring in front of the fronto-parietal ridge on the skull. The body is higher at the shoulder than at the rump, and the forehead, head, and neck are provided with a long woolly mane, while the chin has a well-developed beard. Instead of thirteen pairs of ribs, as in the ox, the European bison has fourteen and the American fifteen pairs.

As already observed the European bison is now only preserved in the small Russian forest of Bialowieza, and occurs wild in the Caucasian district of Kuban. It had within historic times a much wider distribution; having been, two or three centuries ago, quite common in Prussian Lithuania and Hungary, while earlier still it ranged throughout the forest tracts of Germany and Switzerland.

In the preserve referred to, the herds number some eight hundred individuals; their increase is slower in the forests than in captivity, and this is perhaps one of the reasons of the gradual extirpation of the species. Formerly they attained a greater size than at present, a length of thirteen feet with a height of seven feet at the shoulder having been recorded, whereas at the present day they rarely measure more than eleven feet in length. The general color of the hair is light brown, which darkens however on the sides of the head, beard, and legs, and becomes black on the tail. The cow resembles the bull in color, but is much smaller, and its horns are less developed.

When abundant the bisons must have caused much damage in the forests they inhabited, for their food consists of buds, shoots, and bark. In winter probably lichens and dried grass afford additional sustenance, and in summer herbage of various kinds. The bulls lead a comparatively solitary life except at the rutting-time in August and September. The calves are dropped in thickets in May or June, and jealously guarded by the mothers for some time. Old bulls are said to live to the age of forty to fifty years; cows, however, die considerably younger.

Our American Buffalo or Bison (*Bison americanus*) differs from its European congener in several particulars; not only are the head and forequarters heavier, but the forehead is broader, the nose more vaulted, the ear longer, the hump on the withers much higher, the hindquarters and the limbs more slender, and the tail much thicker and shorter. The black horns are thicker, blunter, less curved, and do not converge at their tips—their anterior outlines being somewhat convex, owing to a slight backward projection. They are more slender and elegant in their form in the cow than in the bull. The hair of the coat is distributed in much the same way, and is of a similar umber brown color, except in rare albino varieties, possessing more lustre when it is renewed, but becoming dimmer and grayer as the shedding time approaches. The cow has less hair on the forequarters than the bull, and only attains about four-fifths of his size. Compared with the bison the buffalo bull is considerably shorter, but much higher at the withers, for while a large bull only attains a length of eight and a half to nine and a half feet, the height at the shoulder is some six and a half feet, and at the rump only five and a half. The tail is about twenty inches long, inclusive of the hair twenty-six. The carcass weighs from twelve hundred to two thousand pounds.

The abundant winter coat, so necessary to protect its wearer from the cutting winds which sweep over the prairies, is shed with the approach of mild weather. It is first detached from between the fore-legs, and remains longest on the hump, coming off in patches, not without considerable rubbing on the part of the owner, who by March is in a very ragged condition.

The buffalo formerly ranged over the whole of the eastern United States, to the Atlantic Ocean, and southward into Florida. It is now mainly confined to northern

Bison europæus, European bison.



Texas, New Mexico, Colorado, Kansas, Indian Territory, Montana, and Dakota, although it extends into British territory as far as the sixty-third or sixty-fourth parallel. The advance of civilization toward the west has had the result of driving the buffalo further and further in this direction, until now it has penetrated into the basin between the Rocky Mountains and the Cascades, having been killed on various tributaries of the Columbia River. It now occurs, likewise, further north than it formerly did, a fact which



FIG. 153. — *Bison americanus*, bison.

is solely attributable to the persistent persecution to which it has been subjected by skin-hunters.

The buffalo is more sociable in his habits than any of his immediate relatives; yet the immense hordes which formerly ranged over the continent were really formed of many small herds, only joined during the southerly migration in July, while these separated themselves in the spring, on their return towards the north, making the migration northwards much less conspicuous. Solitary animals are generally found to be old bulls, unable to keep up with the pace of the herd. The migratory habit appears to

be less marked now than formerly; a phenomenon which probably is due to the animals remaining in those places where they are least persecuted.

The gait of the buffalo is at all times more active than that of other oxen. Not only is the ordinary walk brisk, but the trot and gallop enable him to cover the ground very rapidly. For a mile or so he is a good match for a horse. The shape of the withers, and the peculiar character of the gallop, cause the surface of a moving buffalo herd to have a peculiar wavy appearance. Obstacles rarely cause the buffalo to swerve on their migrations from the well-trodden buffalo paths; even rivers of a mile in width are safely crossed. This onward pressing of the immense hordes in one direction is very often the cause of the death of large numbers, for if a landing be not effected on the other side of a river which has to be crossed, or if the water happens to be covered with thin ice, the vanguard do not appear to be able to apprise those following of the danger, and are consequently pressed on to destruction.

In their fondness for water the buffaloes resemble many other members of the family. If not able to gratify this by plunging into a stream they scrape for themselves holes in which water collects, which are successively deepened by different occupants, and are known as buffalo wallows. The peculiar appearance presented by a buffalo which has just emerged from such a mud-bath may be readily imagined. The mud dries, of course, and cracks off in time, or is removed by the next rain-storm.

The rutting season lasts for a month, in September. Before pairing takes place, the bulls fight with each other for the good graces of particular cows, but according to Audubon these combats rarely, if ever, result in the death of the combatants; for the horns are not sufficiently sharp to penetrate the thick cushions of fur which cover the head and forequarters. If they do not terminate fatally, yet a good deal of passion is shown by both combatants, for in the intervals of their rushing at each other the ground is pawed, the tail held erect or lashed from side to side, and a low bellow is emitted. After pairing the bull and cow remain together till early spring, when the cow retires to some wooded district to calve, which it does in March or April. Thereafter the cows join each other, so that the herds met with at this time of the year are either solely formed of cows and calves or else of bulls. The calves grow quickly, and are soon able to take care of themselves, although furiously defended by the mother in any danger. After the rutting season the bulls are out of condition for the whole of the winter, but the cows generally put on a good deal of fat, and afford tender, juicy meat.

The buffalo is almost exclusively hunted on horseback, trained horses being forced up alongside selected animals in the herd, so as to allow of a shoulder shot from a short carbine or revolver. The chief danger to be anticipated is an accident to the horse; but it must not be forgotten that, like other members of this family, even when mortally wounded, the buffalo will make his most desperate efforts to avenge himself. Occasionally herds may be approached by stalking, a well-beaten buffalo-path being the best locality for the hunter to select for this form of sport.

When a buffalo herd is alarmed the cows generally lead off, the bulls occupying the rear. If one of the number be wounded when the herd is not in full career, his comrades generally exhibit sufficient curiosity or sympathy to leave time for another shot.

The rapid extermination of the buffalo is largely due to the wholesale slaughter which has been carried on for the sake of their skins. Their numbers were not materially reduced by the Indians before the skins became a marketable commodity, even

in spite of the fact that immense numbers were killed for food ; for their rate of increase was sufficiently high to compensate for the numbers succumbing to the hunter, the wolf, or the various accidents of their existence. That the slaughter has been, and still is, ruthless and improvident, is sufficiently indicated by the remark of Colonel Dodge, that one skin that comes to market represents from four to six animals slain.

Not only are the skins useful as "robes," but leather of a superior quality is made of the hides. The Indians in fact not only depended upon the buffalo for food and raiment but bones, horns, hoofs, and sinews were all turned to account. The flesh of



FIG. 154. — *Bibos gaurus*, gaur.

both bulls and cows, at certain periods of the year, is tender and juicy, the hump and tongue especially being celebrated as the sportsman's tidbits.

In frontier farms various attempts have been made to make use of the enormous strength of the buffalo for draught purposes, and from the success of these there is hardly room for doubt that such trials are deserving of more extensive imitation. If taken sufficiently young the buffalo becomes readily domesticated, and loses a great deal of its natural ferocity.

The American buffalo is now no stranger to the menageries and zoological gardens of the world, for it readily accustoms itself to captivity, prospering on the food ordi-

narily provided for domestic cattle, and propagating much more freely than is usual with animals in confinement. It is generally observed to remain comparatively quiet through the day, but is restless at night.

Although the herds of buffalo have been more than decimated within recent years, yet the entire extermination which threatens its European congener will hardly overtake it for many a generation. The protection which is afforded to the larger American game by the Yellowstone national park is not to be overlooked, and will be of

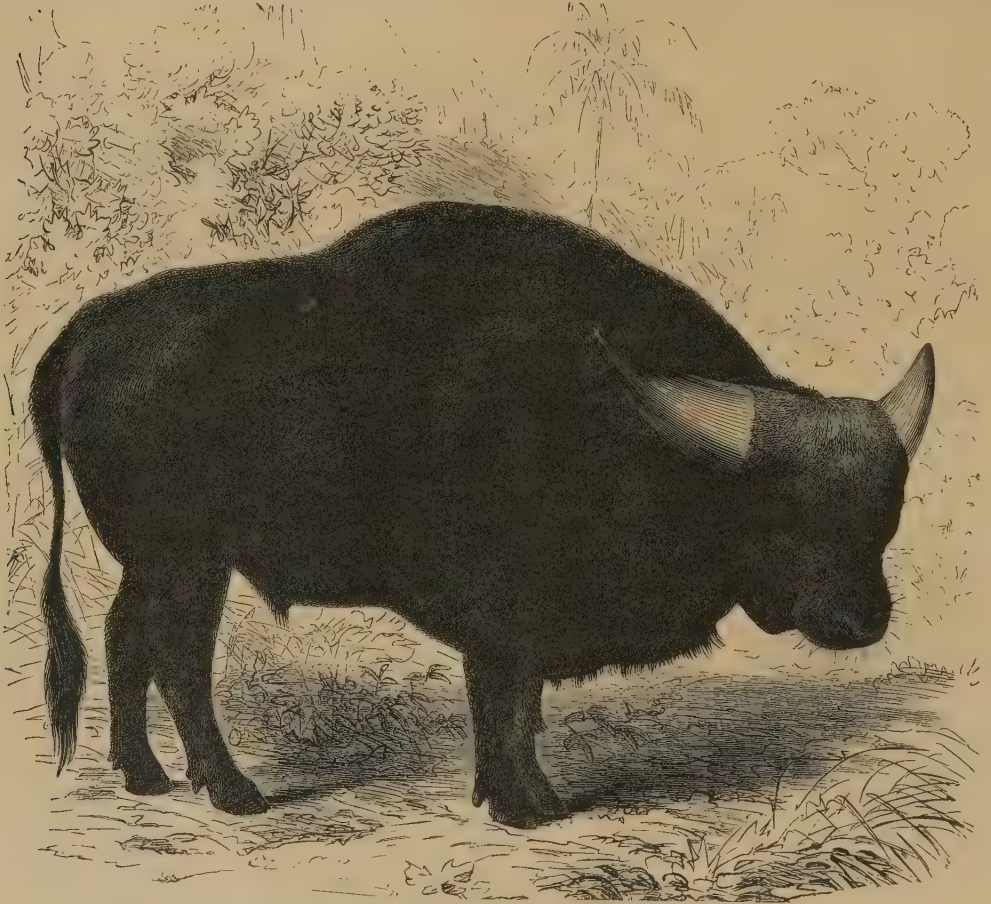


FIG. 155. — *Bibos frontalis*, gayal.

ever-increasing importance. Rigid game-laws are nevertheless a prime necessity, and are especially required to check the wanton slaughter of the skin-hunters, who utilize the hides alone, while the carcasses are left to rot on the prairies.

The East Indian wild cattle are generally referred to a separate genus, *Bibos*, the species of which may, however, be only local races. We figure three of these forms, the Gayal (*B. frontalis*), the Gaur (*B. gaurus*), and the Zebu (*B. indicus*).

The gayal owes its specific name to the immense development of the forehead, and is further characterized by the thick conical horns, the extreme height at the shoulder, length of tail, and the deep black coloring.

The gaur, on the other hand, has much slenderer horns, thick folds of skin on the neck, less height at the shoulder, and a short tail, while its coloring is deep brown and yellow.

The gayal appears to be a mountainous form, chiefly recorded from Bengal; the gaur, on the other hand, extends through the jungles of the whole peninsula. These forms are replaced in Java, Borneo, and Sumatra by the Banteng (*B. banteng*), the horns of which are thickened at the base, curved directly outwards, upwards, and then inwards. Its coloring, grayish-brown, is variegated by paler hues on the rump and legs, and the tail is of a length intermediate between that of the gayal and gaur.



FIG. 156. — *Bibos indicus*, zebu.

The zebu differs from these forms in the possession of a well marked hump on the shoulder, long pendulous ears, excessively short horns, and in the coloring, which is more variegated (sometimes piebald), and passing from reddish yellow to white. The sacred bulls of the Hindus belong to this species, are pampered and fed by the natives, and must not be touched by them. Although found occasionally in a wild state it is possible that the zebu is merely the result of domestication of one or other of the above-mentioned wild forms.

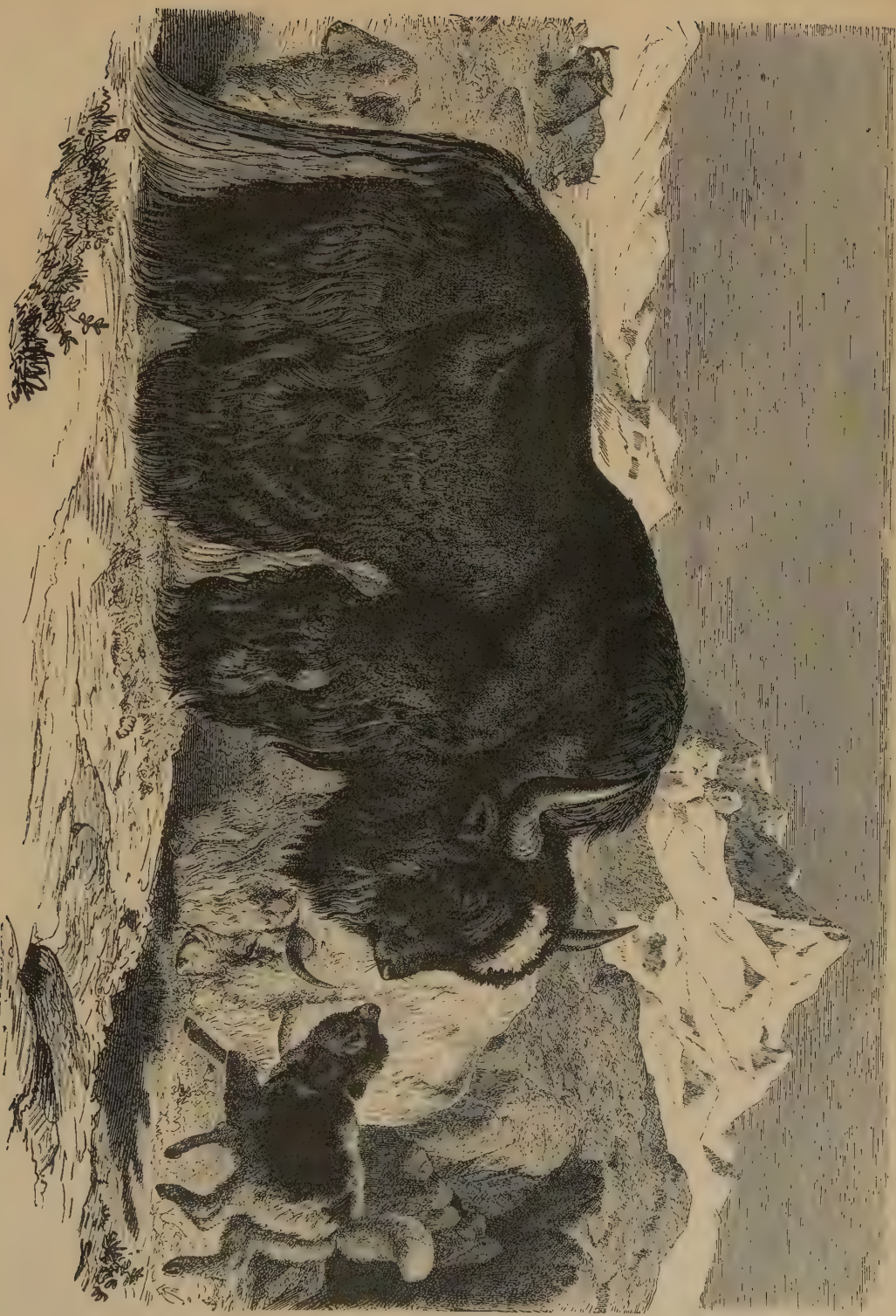
Like the zebu, the Sanga of Africa (*B. africanus*) is provided with a hump, but differs from the allied species in the long horns, which are three feet long, close at their origin, but then curve outwards, upwards, and finally inwards. Sir S. Baker, in his "Ismailia," thus describes the uses to which these cattle are put in Abyssinia:—

"There are countless herds throughout the country, but the natives have a great objection to killing them, and merely keep the cows for their milk and the bullocks to bleed. The cows are also bled periodically, and the blood is boiled and eaten, much in the same manner that black pudding is used throughout Europe. A herd of cattle will thus provide animal food without the necessity of slaughtering. The great traveller, Bruce, was discredited for having described a fact of which he was an eye-witness. This was the vivisection of a cow driven by natives, who cut a steak out of her hind-quarters. I had a bull with a very large hump. This animal was very handsome, and was kept for stock. I observed that the skin of the hump showed a long jagged scar from end to end, and my people assured me that this bull had frequently been operated upon. It had been the property of one of the slave hunter's parties, and they had been in the habit of removing the hump (as a surgeon would a tumor). This is the most delicate portion of the meat, and I was assured that the hump would always be replaced by a similar growth after each operation."

One of the most curious members of this family is the Yak (*Poephagus grunniens*), from the high plains of western Thibet, which occurs both in the wild and domesticated condition. It is valued greatly for its hide and hair, the white tails especially being sought after by the Chinese, who dye them red and use them as tassels. The flesh and milk are also excellent; so, as the yak is unwearying as a beast of burden, it is invaluable to the inhabitants of those districts where it occurs. The yak is most at home in the coldest parts of these regions, and the great development of its hairy covering is obviously an adaptation to its habitat. The hair is curly on the head, but the neck and the outer sides of the legs and the flanks have long, soft flowing hair, which hangs down to the ground, as does the tail. The height at the shoulder is exaggerated by a thick mane, and, indeed, the animal appears larger than it really is, owing to the character of its coat. The cows are much smaller than the bulls, which equal oxen of large size in their dimensions. In the wild condition herds of great size are found, consisting mainly of cows, calves, and young bulls; these divide into smaller herds for the sake of obtaining the scanty nourishment which their mountainous home affords, but at a sign of danger they speedily collect, the calves being gathered to the centre of the herd. The pursuit of the yak is not without danger, for it charges with great ferocity when wounded, and it is very difficult to place a second shot. As a domesticated animal it gives little trouble, for it forages for itself, requires no stall, obeys the call of the Thibet maidens at milking-time, and yields an abundant supply of excellent milk. The yak has been found to be fruitful with cattle of other species.

The next genus of this group (*Bubalus*) embraces the Buffalo of India and Africa; the former having been also introduced as a domesticated animal in southern Europe and Egypt, where it is much valued on account of the little care which is required in foraging for it. It appears to prefer the coarse grasses and herbs of its native swamps to the fodder generally supplied to domestic animals, and evidences its swamp-loving habits by the readiness with which it takes to water. The horns are of considerable size, three-cornered in section, thickened and annulated at the base as in the African forms. An Indian variety, with colossal horns, *B. arni*, is the giant of his tribe, and appears to be as formidable an antagonist in the hunt as the species next to be described.

The commonest form of African Buffalo is *Bubalus caffer*, which was once distributed over all Africa south of the equator, but now is undergoing gradual extermination



Poephagus grunniens, yak.

through the value of its hide. At one time common in Cape Colony it is now scarce even in Zulu land, and hunters go as far as the Matabele country to secure the hides.

Like its congeners to be afterwards referred to, the forehead is short and convex, the base of the horns, especially of the male, become wider with age, so as to cover (and protect) the skull, and the hairy covering is scanty except on the ears, which are



FIG. 157. — *Bubalus caffer*, African buffalo.

of great size. The general color of *B. caffer* is black, the horns are much larger than those of the other species, being as much as twice the length of the skull: they decline from the horizontal and dip downwards and backwards, the tips, however, being inclined forwards. The whole of the basal anterior surface is raised into convex bosses. This is the largest of the African buffaloes, attaining a height of fifty-nine inches at the shoulders.

All African hunters agree that this species is one of the most dangerous to approach, especially when wounded; for a fallen buffalo will very often recover sufficiently to

make a last attack more desperate than any former one. One of the most recent travellers, Holub, in an account of "Seven years' residence in South Africa," observes:—

"Nothing can exceed the cunning that a buffalo will exhibit when it is wounded or infuriated. Having better powers of discrimination, it is more wary than a hippopotamus, and consequently is not so dangerous to an unarmed man; but once provoked it will fight to the bitter end. It generally makes a little retreat, and conceals itself behind a bush, where it waits for the hunter, and when he comes up makes a dash at him. Attacks of this kind are by no means infrequent, and huntsmen of considerable experience have been known to be outwitted and seriously injured by these South African buffaloes. Sometimes the angry brute will content himself with tossing its victim into the air, in which case the mischief is generally limited to the dislocation or fracture of a limb, but far more often it holds its antagonist down upon the ground, whilst with its feet it tramples him to death. I heard of an instance on the Limpopo, where a white man and three negroes were killed, and a fourth negro much injured, all by a single buffalo bull."

Attempts have been made to domesticate the buffalo at the Cape, but it has been found to be less hardy than the ox, perhaps on account of their natural habit of resting during the heat of the day in the shade. They visit the water pools once in the twenty-four hours, at night or in the afternoon, and it is then that hunters most conveniently approach them. The first sign of the proximity of a herd is the sound caused by their rubbing their horns on the trees. Such herds, when alarmed, will stampede, but most danger is to be apprehended from solitary old bulls. Although the adult buffaloes are black, the calves, which are dropped in September, are of a dark brown color. Like other African animals the buffaloes are frequently accompanied by birds searching for vermin.

Two other species of African buffalo are now distinguished by Sir Victor Brooke. These are *Bubalus aequinoctialis* of north-eastern Africa, and *Bubalus pumilis* of western, west equatorial, and central Africa. The former measures fifty inches high at the shoulder; its general color is dark brown; the horns are short and do not recede much from the plane of the eyes. The latter (sometimes known as *B. brachyceros*) is only forty-two inches high at the shoulder; is of a bright yellow, except the nose and legs, which are black; the horns are slightly compressed at their bases, directed upwards, and do not tend to cover the forehead so much as in the other species. The hunting of this latter species is by no means so dangerous as that of the South African form.

More nearly allied to the buffaloes than any other type of oxen is the small wild cow of Celebes, *Anoa depressicornis*. According to Wallace its Malay name, Sapi-Utan, means forest-ox; it inhabits the mountainous regions of the island, and never occurs where there are deer. It is somewhat smaller than a small highland cow, has a low-hanging dewlap, and long straight horns, ringed at the base and sloping backwards over the neck, which gives it some resemblance to the African eland.

The second sub-family, Tragelaphinæ, embraces a number of the handsomest African antelopes, approaching the oxen most closely in their characters, and thus sometimes known as the bovine antelopes.

Of these the Eland (*Oreas canna*) is certainly the most ox-like. Of all the South African antelopes this one appears to be the most liable to extermination as the hides are much valued. It is carefully preserved at one locality in Natal, otherwise, as

Selons observes, it is now extinct in Cape Colony, Natal, Orange Free State, Transvaal, and almost so in all the countries watered by the tributaries of the Limpopo to the west of the Matabele country. In the Kalahari desert, along the river Chobe, and north of the Zambesi, it is still, however, plentiful. The skins from some districts have distinct white stripes on each side, from others present no trace of such. The prevailing color is a bright yellow tan, but old bulls, from the scantiness of the hair, appear of dark slate color. An eland bull measures five feet eight inches at the withers, its horns two feet six in length, while those of the cow measure up to two feet ten inches.

With regard to the hunting of the eland we learn the following from Holub:—“Of all the antelopes the eland, especially the male, is the most lusty and well fed, its heart having been known to be imbedded in a mass of fat weighing twenty-five pounds; the animal is consequently generally so short-breathed that it can be readily overtaken or speared. The Masarwas are very fleet-footed, and skilful in hurling their assegais so as mortally to wound the heart or lungs. Mounted Dutch and English hunters chase the elands in the same way as giraffes, right up to their wagons, where they shoot them down, thus sparing themselves the trouble of having to transport the skins or carcasses from the hunting-ground. I have been told by hunters and natives, and I think it quite credible, that without any great difficulty elands may be tamed and trained to draw or to carry light burdens.”

Schweinfurth suggests that the eland owes its name to the imagination of some well-read Boer to whom it appeared like the mythical creature of his fables and heroic songs, for only as such could the elk have been known to the worthy Dutch colonists. “But however little, as far as regards either the color of its coat, or the shape of its horns, the *Oreas* may have in common with the elk, still I must confess that by its size it could not do otherwise than remind one of the stately game of my Livonian home; and the shaggy hair hanging in full crop from the neck, the bushy bristles on the forehead, and above all the thick black mane upon the withers, all combined to increase the resemblance. Far more striking, however, is the analogy of this animal with the zebu races of Africa, which exhibit many points that are common to the whole antelope type. The short leg, the elevated round body, the long hanging dewlap, the hump-shaped withers, and the light bay color of the skin are characteristics of this race that justify a comparison of the eland with them far more than with the elk.”

The stripes which are possessed by some elands are very characteristic of the Harnessed Antelope (*Tragelaphus scriptus*). This is a West African form, which, in addition to the white stripes disposed like a harness, bears some twenty-three white spots on the haunch, and two or three on the shoulder. The adult males in the Cape Colony are brownish black, the females are light reddish brown; but on the Chobe river the spots are more numerous, the general color is redder, and there is an erectile white mane along the dorsal line. The horns average about a foot in length. The Boschbok of the Dutch colonists (*T. sylvaticus*) is a bush-loving form which is found everywhere in the belt of bush round the coast-line of Cape Colony and Natal down to the water's edge. It is a timid animal occurring in small herds of young males and females, while the old males are solitary in their habits. Its markings are much the same as in *T. scriptus*, but they are subject to much variation.

T. spekii is a swamp-loving form from the interior of Africa, living in the reed beds of the Mababe, Chobe, and other rivers, and only emerging from these at night.

It is difficult to shoot because it remains in water immersed up to the nostrils. The Kaffirs paddle quietly up toward them and assegai them, or else they fire the reeds. The adult male is equal in size to the leche antelope, which it resembles in its habits, but its hair is silkier. It is known as Nakong and Nzoe by the natives. Speke, in the "Source of the Nile," to whom the species is dedicated, describes it as being faintly spotted instead of striped, and as "having toes so long that it could hardly walk on the dry ground, whilst its coat was also well adapted to the moist element it lived in, was long, and of such excellent quality that the natives prize it for wearing almost more than any other of the antelope tribe. The only food it would eat was the tops of the tall papyrus rushes; but though it ate and drank freely, and lay down very quietly, it always charged with ferocity any person who went near it."

The skin of another species of this genus, closely allied to Speke's antelope, has been recently sent from Gaboon (*T. gratus*). It has the same long, coarse hair, and long tarsus and toes, which indicate aquatic and marsh-loving habits. Its fur is a deep chestnut with three or four rows of spots on the sides of the body. *Hydrotragus* has been proposed as a generic name to include these two species.

The Kudu of the Kaffirs, Nellut of the natives of Abyssinia (*Strepsiceros kudu*), was once common in Cape Colony, but is now only found further to the north. It has also been hunted for its hide, which is fine but durable. The finest specimens come from Zululand where the best pasturage is to be had. According to Selons a few kudus still linger in Cape Colony. From the Limpopo to the Zambesi and northwards it occurs in the neighborhood of all the rivers, being found more plentifully in hilly country covered with dense thickets. The ground color of female kudus and young males is a reddish or grayish brown, with eight or nine long white stripes on each side; but the old males become a deep blue gray, owing to the skin showing through the scanty hair. The horns, which are only present in the male, are spiral, with smooth, glistening points; they may measure up to four feet, with a spread from point to point of two feet six inches. The male stands about thirteen hands high at the shoulder.

Belonging also to this sub-family is the Nilgau (*Portax pictus*), an Indian antelope not uncommon in zoological gardens. It is commonest between Delhi and Lahore, and differs from the other members of the group in the long bunch of hair on the throat, and the black mane which stands especially high over the withers. The horns are short (hardly eight inches in the male) and slightly curved. The general coloring is brownish gray, but there are some white markings on the face and feet.

The third sub-family embraces the Oryx Antelopes (*Oryginæ*), which are regarded by some authorities as the originals of the unicorns of the ancients,—a glance at our profile figure of *Oryx beisa* will readily explain on what grounds. This species like the others is a desert form of large size, and occurs on the coast of Abyssinia. The horns project almost straight backwards with little spread, are about three feet long, and annulated at the base. The neck is stout, the shoulders high, and the tail bushy towards the end. The general color is yellowish white, but there is a good deal of pure white on the face, legs, and belly, and some characteristic black marks, giving a variegated aspect to the coat. Such are the triangular black marks on the face, and the oblique stripe below the eye. There are no suborbital or inguinal glands in this genus.

The *Oryx capensis* of South Africa, or Gemsbok of the Dutch colonists, Kokama of the Bechuanas, is even more striking in its coloring. The black marks on the face

are something like a horse's head-stall, the black of the upper parts of the legs connected by a curved flank mark, and the neck is provided with a reversed mane which is continued into a dorsal stripe widening over the croup. The underparts are mostly white, and the general color of the sleek coat yellowish. The horns are slightly curved, longer and slenderer in the cow (up to three feet six inches) than in the bull, and sometimes made at the Cape into walking-sticks. It is not now common in the Cape



FIG. 158. — *Oryx beisa*, oryx.

Colony, but is abundant to the west; its stronghold is the Kalahari desert and Damara-land, where it is still found in large herds. The gemsbok is very swift, but not so enduring as the hartebeest or the sable antelope. It is said to use its horns to great purpose in its own defence, and in offence during the breeding-time. From a more northern form Bezoar stones are said to be obtained.

Less varied in coloring than the above-mentioned species is another form from North Africa, the *Oryx leucoryx*, in which the horns are slightly curved downwards towards the tips.

The genus *Addax* likewise belongs to this sub-family; the coat is coarser and curly on the forehead; the horns are not so long, and are curved, so that taken together they somewhat resemble the frame of an ancient lyre. The only species, *A. nasomaculatus*, is restricted to the desert regions of East Africa, and gets its specific name from a white mark across the nose.

The two best known species of *Hippotragus*, the only genus of the fourth sub-family, Hippotraginæ, are known as the Roan Antelope or Bastard Gemsbok (*H. equinus* or *leucophæus*), and the Sable Antelope (*H. niger*). The latter was first discovered by Harris, in his hunting expeditions in South Africa. It is now found in north-east Transvaal, but is most abundant in the Matabele country, where herds of fifty (females and young, and one full-grown male) occur. The color of the adult female is a dark chestnut, white underneath, but the old male is jet black. Both sexes are horned, the horns of the male measuring up to forty-five inches on the curve, of the female up to thirty-six inches. The animal is able to defend itself well by powerful side-strokes of these horns.

The roan antelope in size comes next to the eland. At one time found in Cape Colony, it is now, according to Buckley, not found to the south of the Kalahari Desert. It is commonest in Umsila's country, east of Matabele land, but herds of twenty are rare. Both this and the sable antelope will charge savagely when brought to bay, uttering a hissing snort in danger. The horns of the roan antelope are considerably shorter than those of its congener (up to thirty inches on the curve). The female has horns, although the opposite is sometimes asserted.

Schweinfurth describes the first roan antelope he saw as follows: "Except on the belly, which was white, its long hair was all of a brownish gray. It carried its head erect, its ears were long and pointed, its horns massive and very long, its black legs going off into white fetlocks. A stiff mane of bright brown crested its curved neck, and reached to its withers. It had a tail of about nine inches in length appended to a long slim stem. There it stood majestically, I might say, like a stately buffalo when it surveys the region all around before it trusts itself to feed. There it stood, in an attitude at once commanding and defiant. Whenever he moved the grass crackled beneath its tread, and ere long it shifted its place again and turned its full face towards me. I cautiously reached out my hand for a rifle that was lying near me, pushed back the guard, and at the next movement of the beast hit it with a ball right upon the shoulder-blade, from a distance of about ninety paces. The creature reared itself up, then paused an instant, staggered, and let its head sink down as if amazed. I was just about to get hold of a second rifle when there came a sudden crash, and while I was still sitting the animal had fallen just beyond the open portfolio which was lying outspread before me. Fortune had thus cast the noble prey into my clutches. The sound of the rifle had hardly aroused my people, for this is a country where a stray shot does not attract attention for an instant; but my shout of surprise and delight brought them quickly to their feet. Some negroes were soon fetched from the neighboring huts, who shortly completed the work of flaying and jointing the prey. Its head alone weighed thirty-five pounds. The natives informed me that the Mahnya (as the Bongo call this species of antelope) are among the rarest animals of the district, although they live as much in one quarter as another. They are ordinarily found singly, and far separate from any other of their kindred race; and it is said that the largest of them will assail a huntsman, and are as furious when angry as a wild buffalo."

Gazella dorcas, gazelle.



The Maharif (*H. bakeri*) is a third species, of a mouse color, with black and white stripes upon the face. Baker, in his "Albert Nyanza," describes the horns as exactly like those of the roan antelope, being massive and corrugated, bending backwards to the shoulders. "The withers are extremely high, which gives a peculiarly heavy appearance to the shoulders, much heightened by a large and stiff black mane like that of a hog-maned horse. I have a pair of horns in my possession that I obtained through the assistance of a lion who killed the maharif while drinking near my tent; unfortunately the skin was torn to pieces, and the horns and skull were all that remained."

The Common Gazelle (*Gazella dorcas*) of North Africa may be regarded as the type of the fifth sub-family, Gazellinæ, which includes some twenty-three species of small, mostly desert-loving forms. Baker, in his "Nile-Tributaries of Abyssinia," gives the following interesting account of the species illustrated in our plate:—

"The buck gazelles so exactly resemble the color of the sandy deserts which they inhabit that they are most difficult to distinguish, and their extreme shyness renders stalking upon foot very uncertain. I employed an Arab to lead a camel, under cover of which I could approach within a hundred yards. A buck gazelle weighs from sixty to seventy pounds, and is the perfection of muscular development. Born in the scorching sun, nursed in the burning sand of the treeless and shadowless wilderness, the gazelle is among the antelope tribe as the Arab horse is among its brethren—the high bred and superlative beauty of the race. The skin is sleek as satin, of a color difficult to describe as it varies between the lightest mauve and yellowish brown; the belly is snow-white; the legs, from the knee downwards, also white, and as fine as though carved from ivory; the hoof, beautifully shaped, tapers to a sharp point. The head of the buck is ornamented by gracefully-curved, annulated horns, perfectly black, and generally from nine to twelve inches long on the bend; the eye is the well-known perfection—the full, large, soft, and jet black eye of the gazelle.

"In the desert are numerous shallow, sandy ravines, in which are tufts of a herbage so coarse that as a source of nourishment it would be valueless to a domestic animal. On this gazelles exist; are in excellent condition though they never fatten; a mass of muscle and sinew; it is the fastest of the antelope tribe. The Arabs course them with greyhounds, and sometimes they are caught by running several dogs at the same time; but this result is from the folly of the gazelle, who at first distances his pursuers like the wind, but secure in its speed it halts and faces the dogs, exhausting itself by bounding exultingly in the air. In the meantime the greyhounds are closing up and diminishing the chance of escape. As a rule, notwithstanding this, the gazelle has the best of the race. The flesh, although tolerably good, has a slight flavor of musk; this is not peculiar to the gazelle but to most small antelopes.

"The skins of gazelles are used for making girbas or water-sacks. The animal having been hung up by the hind legs, an incision is made along the inside of both thighs to the tail, with some trouble the skin is drawn off the body towards the head precisely as a stocking might be drawn from the leg, thus forming a seamless bag, open at both ends. The skin is buried in the earth for twenty hours, washed, the hair detached, and tanned by soaking for several days in a mixture of the bark of a mimosa and water. It is withdrawn from this daily and stretched upon the ground; then scrubbed with a rough stone—fresh mimosa bark well bruised, with water, being rubbed in by friction. Four days are required to tan the skin of a gazelle, which is much valued for its toughness and durability. The aperture at the hind quarters is sewn up, and the opening of the neck is closed when required by tying. A good

water skin should be porous to allow the water to exude enough to moisten the exterior, thus keeping the water within deliciously cool.

"The Arabs usually prepare their tanned skins with an empyreumatical oil made from a variety of substances, the best of which is that from the sésamé grain. This has a powerful smell, making the water so disagreeable that few Europeans can drink it. This oil is black, and much resembles tar in appearance; it has the effects of preserving the leather and of rendering it perfectly water-tight. In travelling each person should have his own water-skin slung on his shoulders: none so good as a small-sized gazelle skin containing two gallons."



FIG. 159. —*Gazella euchores*, springbok.

The Ariel of the Arabs (*G. dama*) is similar in form and shape of the horns, but is as large as a fallow deer, and has a milk-white rump. Speke and Grant discovered another beautiful species in Ugogo (*G. granti*), which has horns twenty-four inches long in both sexes, compressed from side to side, at first diverging but afterwards converging. The coat is like watered silk, of a very rich fawn color tinged with purple. Allied species are *G. soemmerringi* and *G. mohr*. *G. walleri*, from near Zanzibar, has the back of the head prolonged backwards in a degree unknown in the other species.

The Springbok of the Dutch colonists (*Gazella euchores*) represents this genus in South Africa. The most marked peculiarity of this form is the white stripe of long hairs along the dorsal line, passing into the white of the hind quarters at the tail.

This stripe is folded so as to be concealed when at rest, but when the animal is in flight opens out so as to make the back look quite white. According to Buckley it is still common in Cape Colony, and as far as the Zambesi. Holub notices that the springboks in going to drink act as pioneers to other game, and that blessingboks and gnus follow in their wake when all is safe. They leave their fawns all day, returning to them in the evening. In books on South African travel no game is mentioned more frequently than the springbok. We accordingly extract from Holub's work the following account of the animal and the modes employed in hunting it:—

“The gracefulness of its movements when it is at play, or when startled into flight is not adequately to be described, and it might almost seem as if the agile creature were seeking to divert the evil purposes of a pursuer by the very coquetry of its antics. Unfortunately, however, sportsmen are proof against any charms of this sort; and under the ruthless hands of the Dutch farmers, and the unsparing attacks of the natives, it is an animal that is every day becoming more and more rare. The bounds of the springbok may perhaps be best compared to the jerks of a machine set in motion by watch springs. It will allow any dog except a greyhound to approach it within quite a moderate distance; it will gaze as if entirely unconcerned while the dog yelps and howls, apparently waiting for the scene to come to an end, when all at once it will spring with a spasmodic leap into the air, and alighting for a moment on the ground six feet away will leap up again, repeating the movement like an india-rubber ball bounding and rebounding from the earth. Coming to a standstill it will wait awhile for the dog to come close again; but ere long it recommences its springing bounds, and extricates itself once more from the presence of danger. And so, in alternate periods of repose and activity, the chase goes on till the antelope, wearied out as it were by the sport, makes off completely, and becomes a mere speck on the distant plain.

“But the agility of the nimble creature cannot save it from destruction. Since the discovery of the diamond-fields thousands of them as well as of the allied species, the blessingbok and the black gnu, have been slain. The Dutch farmers, who are owners of the districts where the antelopes abound, are excellent shots, and their worst enemies. On their periodical visits to the diamond-fields they always carry with them a rich spoil, and whilst I was there in the winter months, from May to September, I saw whole wagon-loads of gazelles brought to the market. Nevertheless, in spite of the slaughter, it is a kind of game that as yet has by no means become scarce, and it is sold in the daily markets at ‘Kimberley’ and ‘Dutoitspan’ at prices varying from three to seven shillings a head. Springbok hunting is interesting, and is generally done on horseback. The horses, which have been reared on these grassy plains, are well accustomed to the burrow-holes and ant-hills with which they abound, so that they give their rider no concern, and allow him to concentrate all his attention upon his sport. A gallop of about two miles will usually bring the huntsman within a distance of two hundred yards of a herd of flying antelopes. A slight pressure of the knees suffices to bring the horse to a standstill, when its rider dismounts and takes a deliberate aim at the victim. Amongst the Dutch Boers the most wonderful feats of skill are performed in this way, and I have known an expert marksman bring down two running antelopes by a single shot from his breech-loader. Other instances I have witnessed when, both shots having missed, or the second having been fired too late, the herd has scampered off to a distance of seven hundred yards or more and come to a stand, when a good shot has made a selection of a special victim for his unerring aim.

There is another method of hunting these springboks by digging holes, two or three feet deep and three feet wide, in proximity to ponds or pools in half-dried-up river-beds. In these holes the hunter crouches out of sight, and shoots down the animals as they come to drink. This kind of chase, or rather battue, is very common in the dry season when there are not many places in which the antelopes can quench their thirst, and is especially popular with the most southerly of the Bechuanas, the Batlapins, and the Barolongs, who are, as a rule, by no means skilful as shots.

"On the plains between the Harts River and the Molapo a different plan is often followed. Several men lie down flat on the ground, either behind ant-hills or in some long grass at intervals of from fifty to two hundred yards, and at a considerable distance — ordinarily about half a mile — from the herd. A large number of men then form themselves into a sort of semicircle, and, having encompassed the herd, begin to close in so as to drive them within range of the guns of the men who are lying in ambush.

"As the weapons are only of the commonest kind, often little better than blunderbusses, the success of the movement of course depends entirely on the first shot. When the party is small they not unfrequently spend a whole day waiting most patiently for the springboks to be driven sufficiently within range. I have myself on one occasion seen a party of six of these skirmishers, after watching with the sublimest patience for many hours, take their aim at an animal that had been driven off, with a roar that made the very ground tremble; the volume of smoke was immense; six dusky faces of the Bechuanas rose from the grass; every eye was full of expectation, but as the cloud rolled off it revealed the springbok bounding away merrily in the distance. The six shots had all missed.

"The snare called the hopo-trap, described by Livingstone in his account of gazelle-hunting among the Bechuanas, I never saw anywhere in use. It would probably be now of no avail, as the game is much wilder and less abundant than it was in his time. A still different mode of chasing springboks has been introduced by the English, who hunt with greyhounds, not using fire-arms at all. Mounted on horses that, in spite of being unaccustomed to the ground, do their work admirably, the pursuers follow on until the gazelles are fairly brought down by the dogs, although it not unfrequently happens that the dogs get so weary and exhausted by the run that the chase has to be abandoned."

Belonging to the same sub-family is the Pallah or Roodebok of the Dutch (*Æpyceros melampus*). Buckley observes that this form occurs from Zululand far into Equatorial Africa. In the winter it is found in large herds which break up in the summer into parties of three, an old male and female and a young one. It is a wood-loving species found near water. The male alone has horns, which may measure twenty inches, are lyrate, but have in the middle an abrupt angular bend. There are no dew-claws in this genus, their place being marked by a black spot.

The Saiga Antelope (*Saiga tatarica*) differs from the rest of the members of this group in its sheep-like face, this resemblance being especially strong in the female. According to Wallace the saiga inhabits the steppes of eastern Europe and western Asia from Poland to the Irtish River, south of 55° north latitude. The erect annulated horns of the male take away the resemblance to sheep. The nostrils at the end of the much prolonged snout are very capacious. A thick tuft of long hair beneath the eye overhangs the cheek, and a fringe of a similar character depends from the ear. It

further resembles sheep in the pushing off of its fleece *en masse*, in jumping, and butting with its horns. It possesses suborbital, interdigital, and inguinal glands.

Further genera are *Procapra*, *Panthalops*, and *Antilope*. The latter has an important Indian species (*A. cervicapra*) in which the horns, present in the male alone, jut straight backwards, but are annulated, and spirally curved in their course. This species has also the various glands mentioned as occurring in the saiga; a further



FIG. 160. — *Antilocapra americana*, prong-horn, cabree.

feature is the prominent lock of hair on the knees. This is absent in *Procapra* (*P. gutturosa*), a Central Asiatic form with projecting crop. *Panthalops* is from Tibet, and is perhaps most nearly allied to the saiga antelope, but is distinguished by a sac-like appendage to the nasal cavity on each side.

With the sixth sub-family (*Antilocaprinæ*) we come nearer home, for its sole representative is the Prong-horned Antelope of the Rocky Mountains (*Antilocapra americana*).

This somewhat singular American species, known familiarly as the Prong-horned Antelope, Prong-buck, or Cabree, has received its name from the fact that there is a

triangular projection from the anterior surface of the horns, about half way up. As all the other hollow-horned ruminants have undivided horns, this species occupies a somewhat isolated position among them in this respect. The snag is almost entirely confined to the horny sheath, for the bony core is only a little broader opposite where the prong is given off. The horny sheath itself presents, during its development, a greater resemblance to agglutinated hairs than does the horn of any other hollow-horned ruminant. Terminally it is round, smooth, and polished; up to the base of the prong, however, it is compressed from side to side, and covered by irregular warty tubercles. The horns are rudimentary in the female, but can generally be felt through the skin. The bony cores project straight up from above the orbits, and give thus a peculiar aspect to the skull.

The most singular phenomenon in connection with the horns of the prong-buck is the deciduous nature of their sheaths. The horny sheaths are regularly cast every year, in October or November, and are then seen to be quite thin at their bases, and massive only at the tips. The bony core is, however, not then exposed, but is found to be covered with a dark hairy skin, the development of the hairs from which probably accounts for the pushing off of the old horns. The cores are covered with this hairy layer till January, during which time the formation of the corneous substance takes place, and the felted hairs upon the outside soon fall off, so that then the point of demarcation between the horn and the hair of the head becomes very sharp. Owing probably to this deciduous character of the horn sheaths, these vary considerably in their outline at different periods of life.

The horns are from eight to ten inches long, and exhibit a good deal of variation in shape, chiefly determined by the point from which the snag projects, and the direction of the terminal curvature. This is generally backward and slightly inward, but occasionally they may curve so as to touch, or even overlap, each other in the middle line.

In size the prong-horn exceeds the domestic sheep, measuring some four feet six inches in length, with a height of two feet six inches at the withers and three feet at the rump.

The general color of the coat is yellowish-brown on the upper, and white on the under parts. The upper surface of the face is brownish, but the sides white; two patches of white on the throat, an upper crescentic and a lower triangular, interrupt the continuous brownish hue, and may fuse with the white on the under parts. The buttocks are pure white, the tail either white or brown, and the legs only brown on the outsides. A short mane of darker stiff hairs marks the middle line of the neck. The long, narrow, pointed ears are yellowish-brown on the outside, but whitish inside. The muzzle is dark brown, and covered with hair except a narrow middle parting. The female has the same markings as the male, only somewhat less distinct. There is no suborbital gland, but the skin is elsewhere richly provided with structures of this character, for there are not only interdigital glands, but one in front and one on each side of the tail, as also one pouring out a yellowish secretion, with a goat-like odor, about an inch and a half below the ear, on each side, reminding one of the similar glands in the chamois.

The eyes are of large size, and occupy a very lateral position, immediately underneath the horns in the male. The hoofs are very narrow and long, and the tracks, consequently, are of an elongated cordate shape. There are no dew-claws, a character which this antelope shares with several of the smaller members of the family.

The prong-horn occupies a wide range, from the Missouri River to the Pacific, and from 53° north latitude southwards into Mexico. It is perhaps now most abundant in Sonora and northwestern Mexico, but was found at one time in immense herds in the San Joaquin valley in California.

A certain amount of migration has been observed, chiefly determined, however, by want of water or suitable food. They avoid the open plains in winter, seeking shelter in more hilly regions, where they are generally to be found in the valleys. They drink once a day, unless abundance of juicy herbage be had, and are tempted to the proximity of salt-licks, like other ruminants. The rutting season is November, at which time, and for a month or two before, the herds are at their largest. During summer, however, the old males lead a comparatively solitary existence. The females calve in May, conceal the young, usually two in number, for a fortnight, after which they are able to use their legs as nimbly as the mother. The hoofs are used by the mothers in defence of their young, and we learn from Clark that the antelope will decoy rattlesnakes into a striking attitude, and then suddenly jump upon them with all four hoofs.

The antelopes are unquestionably the swiftest of the American game, and probably rival many of the larger African forms in this respect. The slimness of the legs and lightness of the build generally point to a high rate of speed.

Various methods are adopted for hunting the prong-horn, for its excellent flesh is much valued in the tracts of country in which it is found. A quarter of a century ago it was so abundant in the Californian markets as to fetch the lowest price of any meat for sale there, in spite of its excellence, but now the game is much scarcer, and such is no longer the case. The curiosity of the antelope is generally taken advantage of by the hunter who wishes to get within range; a handkerchief is tied to the gun and held aloft, when the antelope slowly approaches, showing a great deal of caution. This ruse must be put in practice against the wind, for if the antelope, in his slow approach, scents the hunter, all hope of his coming nearer is over. Horses and hounds are almost useless, such is the swiftness of the prong-horns. The latter are said to be unable to keep their footing in sleety weather, and have been sabred from horseback when the condition of the ground was thus unfavorable. They may occasionally be stalked, but the country they inhabit is so open as rarely to afford the necessary cover to the hunter. They are most easily approached in early morning, when feeding. Although they be widely scattered while feeding if once alarmed they quickly flock together, and take flight in one direction, across obstacles of every sort. The very lateral position of the eyes is said to interfere with their sharpness of vision.

In captivity the prong-horns live only a short time; it appears to be difficult to supply them with food of the right kind, and they pine for the freedom of the open prairies. Cows' milk does not seem to be sufficiently rich to bring up the young on, but even if that difficulty has been got over the antelopes succumb in menageries to various diseases.

The seventh sub-family (*Cervicaprinæ*) takes us again to Africa. The family name is formed on that of the Reedbuck (*Rietbok*) of South Africa (*Cervicapra arundinacea*). This is a handsome yellow-brown creature, keeping to dry ground, in long grass. The horns bend forwards in a hook, and may measure from twelve to sixteen inches along the curve. When alarmed the rietboks whistle like the chamois. Unlike the next members of the group they go in pairs, sometimes forming a small herd. Buckley says that there are still a few in the Transvaal, but they are to be found in great

numbers on the tributaries of the Limpopo, and in the Matabele and Mashuna countries.

The genus *Kobus* is represented by a number of well-known species. Principal among these is the Waterbok of South Africa (*K. ellipsiprymnus*), which extends through central Africa up to Abyssinia, where it is known as the Méhedéhet. Though a heavy animal the waterbok climbs well on the steep stony hills of the country; as its name indicates it is never far from water, and is a good swimmer. The herd number up to twenty; these are either formed of young males or of one old male with the herd of females. There is a white ring round the rump, whence another Dutch name, "Kring-gaat." The flesh is poor, but Baker says that the natives of central Africa greedily drink the hot blood of the waterbok when its throat is cut. It stands about thirteen hands high, and has a rough brown coat. The slightly-curved annulated horns may measure as much as thirty inches in length.

The Leche antelope (*K. leche*) occurs in the marshes of the Botletlie, Chobe, and other rivers. Next to Speke's antelope the leche is the most water-loving form. Like it, it stands knee-deep in water, cropping the tops of the grass above the surface; its feet are hairless between the hoofs and the dew claws, whilst the other forms are hairy there. In the water it bounds, and does not swim even when up to the neck. Large herds are found. The horns are somewhat shorter than those of the waterbok. The Pookoo is a third species (*K. vardoni*) on the banks of the Chobe, but always found two or three hundred yards from the water. It is about the same size as the pallah, is of a foxy-red hue, with black tips to the ears. The male alone is furnished with horns, which measure some sixteen inches on the curve. It does not occur along with the last species. Speke discovered in Uganda the Nsunnu antelope (*K. leucotis*), occurring in large herds in thick bush and grassy plains.

Belonging to the genera *Nanotragus* and *Neotragus* are a number of pigmy antelopes, of which the commonest is the Klippspringer, of South Africa (*Nanotragus oreotragus*). Its Dutch name indicates its habit; for it haunts the "kopjes," or rocky mounds which everywhere rise suddenly from the level land. The male alone has horns, which are, however, only four inches in length; the hoofs are small, and the long bristly hair is much used for stuffing saddles in the Cape Colony. *N. tragulus*, the Steinbok, is spread over the whole country south of the Zambesi. According to Buckley this species loves dry situations, lies in a sort of form in the middle of the day, from which it emerges at night: it feeds in the early morning. A gray steinbok, *N. melanotis*, abounds in the neighborhood of the Victoria Falls. *N. scoparius* has somewhat longer horns, annulated at the base.

The Ben-Israel of Abyssinia may be taken as the type of the genus *Neotragus*, to which the smallest forms of this group belong. All are found in the thickest mimosa-bush, and are very difficult to get at. The horns of the male are almost parallel, with irregular rings on the lower two-thirds.

Resembling the above pigmies in general size and habit are numerous species of *Cephalolophus*, forming the eighth sub-family, Cephalolophinae, of which we figure the best known species, the Duykerbok of South Africa. The horns are small in the male (from three to five inches), and usually absent in the female. The coat is greenish or reddish brown, and is marked by a tuft of hair between the horns. The muffle is particularly large, and there is a bare furrow between eye and nose. Schweinfurth contrasts this species, which is known as the Deloo in the north of Africa, with a species of *Nanotragus*, not referred to above, as follows:—

"There are two little antelopes which are here very common, and which roam about the country in pairs. One of these is the Hegoleh (*N. madoqua*) which appears to be found right through from Abyssinia to the Gambia; the other is the deloo (*Cephalolophus grimmia*) which is known also in the south. They are both pretty and lively bright-eyed creatures, of which the entire length is but little over three feet; they correspond very nearly to a small roe, or the fawn of a fallow deer.

"The hegoleh is all of one color—a light tawny with a grayish throat, not so foxy as the *Leucotis*. The deloo is of a fawn color on its back, with a tinge of yellow in front; its flanks are nearly white, whilst its ankles are black. Its head is very expressive; a black stripe runs along it and terminates in a dark brown tuft; this gives to the female, which has no horns, rather a comical look, running up as it does into a stiff



FIG. 161.—*Cephalolophus mergens*, duykerbok.

peak of about five inches long; in the males this growth is concealed by the short horns. Both kinds are distinguished by the glands of the lachrymal ducts. The *madoqua* has two pairs of these, one pair set under the roots of the ear, making a triangle of an area of half a square inch; the other pair in the tear-pits composing a sort of pouch about an inch long, which consists of a deep fold of skin, and from which is discharged a viscous and colorless matter. Above the tear-glands, towards the nasal bone, there projects on each side from the frontlet a thick pad about three inches long, which seems to have an adenoid texture almost like a tumor. In the same way as with the *Cervicapra* these tear-glands, during any excitement, open themselves like the nostrils of a snorting-horse. The *Deloo* has only one pair of these glands which lie horizontally in a narrow streak across the hollow of the eyes. Both kinds are alike in never venturing into the low ground exposed to floods, and in preferring

the rocky lands which are covered with brushwood. They often get into the middle of a thicket and startle the huntsman by suddenly springing out, in the same way as the Ben-Israel or Om-digdig of Abyssinia (*Neotragus hempridiana*). The flesh of both these antelopes is indifferent for eating as compared with the larger kinds; that of the deloo when roasted having a singular acrid flavor which seems to suggest the unpleasantness of the glands."

An allied genus (*Tetraceros*) is found in the hilly parts of India, and is singular among the antelopes in that it has four horns (*T. quadricornis*), two straight ones behind and two short conical ones above the hinder angle of the eyes.

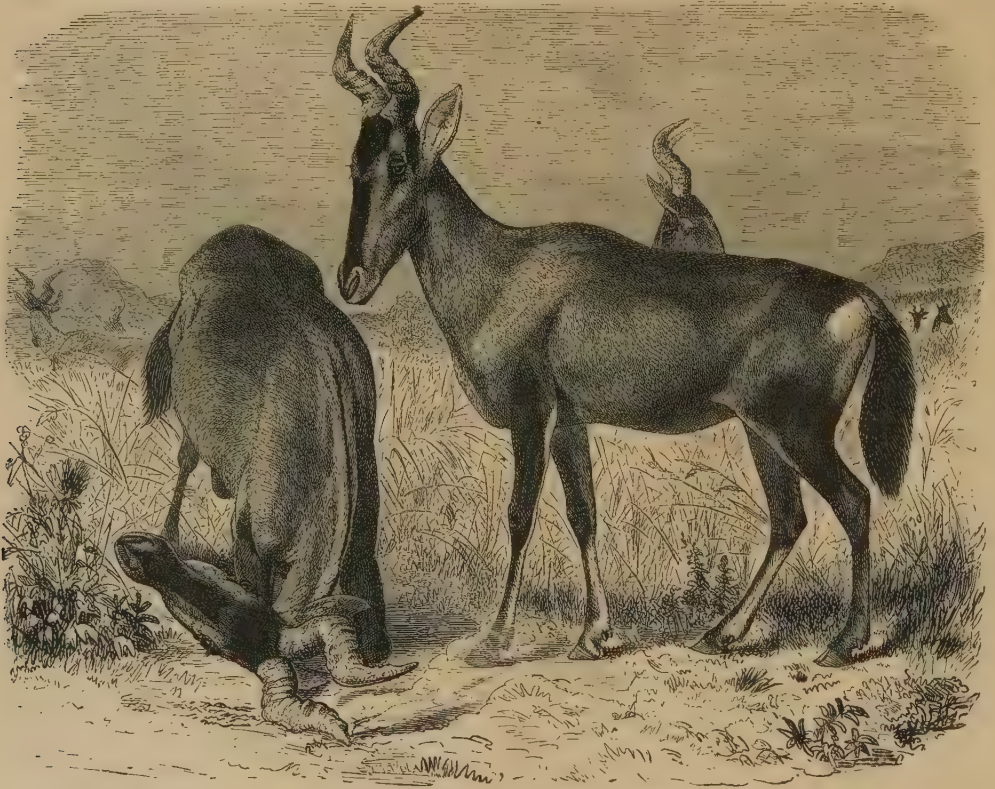


FIG. 162. — *Alcelaphus caama*, hartebeest.

With the ninth sub-family (Alcelaphinæ) we enter upon a group of large antelopes accounts of which are to be met with in narratives of hunting expeditions through all parts of Africa. One of the most frequently mentioned of them is the Hartebeest (*Alcelaphus caama*), at one time very common throughout all the south of that continent, but now very rare except northwards towards the Zambesi and where it is preserved in Natal. This antelope is about five feet high at the shoulders, has a long upwardly-produced head furnished with horns which are close at their origin and again approximate before finally diverging outwards and backwards. There are characteristic black marks on the face and legs, a white mark on the rump, and a bushy tail of glossy black hair. According to Schweinfurth the hartebeest is generally found in small herds, varying in number from five to ten, its haunts being chiefly uninhabited tracts of

wilderness. In the cultivated districts it prefers the light bush forests in the vicinity of rivers though it is never seen actually in the river valleys. It takes its midday rest by standing motionless against the trunks of trees; and by its similarity in hue to the background which it chooses it often eludes all observation. Throughout the rainy season its color is bright—a sort of yellow brown, with a belly nearly white; but in the winter it tones down to a dullish gray.

Schweinfurth in the following language describes a peculiar habit:—"As we advanced, our attention was attracted by a herd of hartebeests sporting together scarcely five hundred paces from our path, and apparently quite unconscious of the proximity of a caravan nearly half a league in length. So regular were their evolutions as almost to suggest the idea that they were being guided by some invisible hand; they ran in couples like the horses in a circus, and kept going round and round a clump of trees, whilst the others stood in groups of three or four intently watching them; after a time these in turn took their places, and two at a time ran their own circuit in the same fashion. How long these movements might have continued I cannot say, but my dogs soon afterwards made a dash in amongst the antelopes and sent them flying in all directions. The circumstance that I have now related may appear somewhat incredible, but I can only say that I had ample time to witness it, and that I was as much surprised at it as my readers can possibly be. I can only imagine, in explanation, that it was pairing-time, and that the animals were blind to all external danger. I remembered I had witnessed something similar three months previously upon the Dgoor. A party of three of us were rambling over a plain covered with short grass when we saw two little hegoleh-bocks (*A. madoqua*) chasing each other upon one side of us; they kept up that peculiar grunting that belongs to their kind. A moment after they were on the other side of us, in another moment they were back again, and by watching them we found that they kept making a circle round the spot on which we were standing, and although we shouted and tried to scare them they persisted in twice more performing their circuit about us."

Holub, who regards the hartebeest as the ugliest of antelopes, accounts for its comparative rarity in certain regions by the fact that it is much hunted for its hide by the Bamangwatos, who use the skins as dresses. When pursued its motions are very awkward, probably on account of the height of the shoulders. In fleetness and enduring power, however, it is only second to the Sassaybe (*A. lunata*), which replaces it in Amaswazi, and is common along the Limpopo into Matabeleland and the Zambesi. Where rare in the south the sassaybe is now confined to the bush, but northwards where it is common it is found in open country in herds of several hundreds. The sassaybe stands higher at the shoulders than the hartebeest; its horns, about twelve inches long, form together a crescent with a general inclination backwards, but without the angular bend of the hartebeest's; and its coloring is different, the black spots on the face being continuous, and the outsides of the upper parts of the legs of a slate color.

A. lichtensteini, the Konze of the Masubias, lives, according to Buckley, on open downs of the Manica plateau north of the Zambesi. Its horns are shorter and flatter at the base than those of the hartebeest, the general color is lighter, the forehead not so long, and the face destitute of the black mark.

Another familiar species in hunting narratives is the Blesbok (*A. albifrons*). Though much hunted this species is still found in countless numbers in the Transvaal and the Orange Free State. In winter they migrate southwards, but in summer are

only found north of the Vaal. Both this and the nearly allied Bontebok or Pied Antelope (*A. pygarga*) are characterized by white marks on the face, to which indeed the blesbok owes both its Dutch and Latin name. The blesbok is somewhat smaller than the bontebok, has a saddle of bluish color which contrasts with the purply-chocolate of the rest of the coat, while the bontebok has dark brown flank marks, although the rest of the coloring is not so gay as in the blesbok. The horns of the latter are greenish, whereas those of the bontebok are black.

Two further species of this genus are figured on our plate; these are *A. tora*, the Tétel of the Arabs, and *H. senegalensis*, which, although of similar stature, are sufficiently distinguished by the shape of the horns.

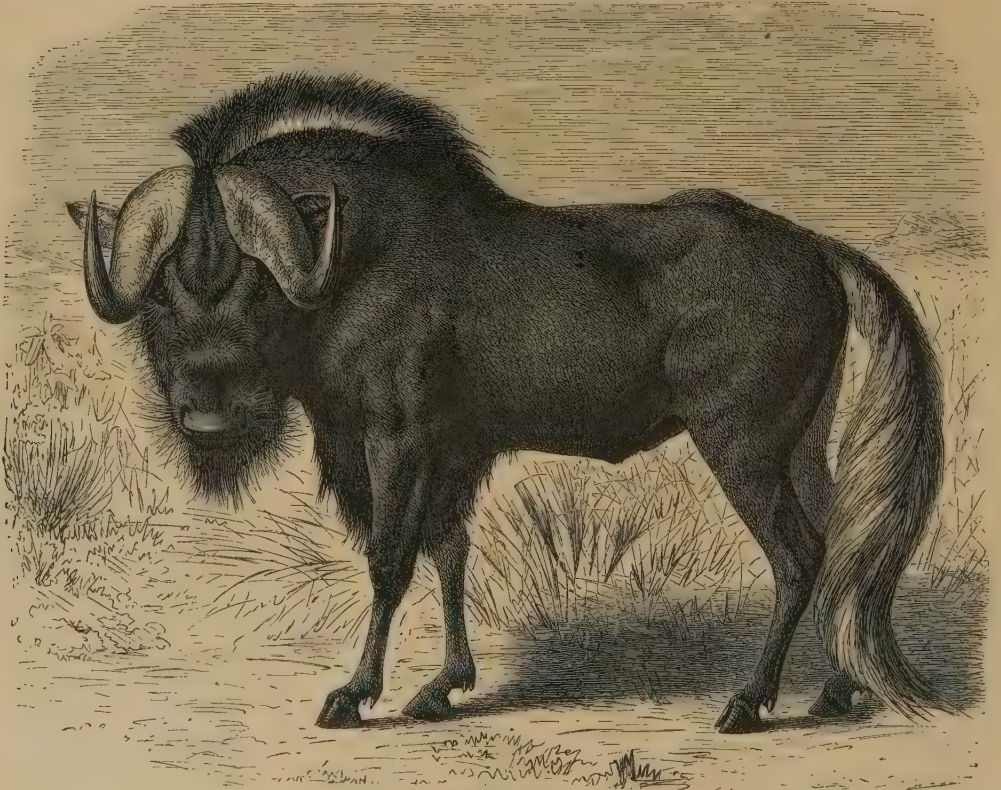


FIG. 163.—*Catoblephas gnu*, gnu.

Two of the most singular of antelopes are the Gnus or Wildebeests (*Catoblephas gnu* and *gorgon*). The former species is now rarely found south of the Vaal except in winter, its numbers having been much reduced through hunting for the sake of the hide which is an article of export from Natal. The gnu is of considerable size, standing four feet high at the shoulder and attaining a length of nine feet. The coat is of deep brown, darker in winter, but the hues of the female are lighter. Both sexes are horned, the horns projecting slightly outwards and downwards, then forming an abrupt upward bend; the bases of the horns are closely approximated in the male. The bristly black hair on the nose, dewlap, and between the fore-legs is no less characteristic than the white hogged mane with its brownish border, and the white horse-like tail.

Group of antelopes. 1. Têtel. 2. Bontebok. 3. Senegal antelope. 4. Blesbok.



The herds of gnus number from ten to fifty, but the old males separate from the herds in summer and lead a solitary life, lying in a sort of lair during the day, in which they are frequently shot by the natives. Both this and the following species wheel in a circle once or twice before setting off when alarmed. The Brindled gnu, or Blue Wildebeest [Kokon, of the Bechuanas] (*C. gorgon*) is still found in Zululand, and abundant in Damaraland. Although larger than the common gnu, it is less wild: its horns are more like those of an ox, and it is readily distinguishable from its congener by the black stripes on the neck and shoulders and the black tail. Its mane is also longer, and the hair on the face more abundant. This species is found very often in company with Burchell's zebra, as the common gnu is found with the quagga.



FIG. 164.—*Catoblephas gorgon*, brindled gnu.

Sub-family ten, *Budorcinae*, embraces two species, which are confined to the Eastern Himalayas, have a sheep-like nose, smooth, round horns, nearly touching each other below, a goat-like tail, and four teats. The Yākin, *B. taxicolor*, is found on high ranges, is swift of foot, and an excellent climber.

Sub-family eleven, *Rupicaprinae*, is likewise a mountain-loving group. It includes two or three varieties of chamois, probably all reducible to one species (*Rupicapra rupicapra*), which inhabits the European Alps from the Pyrenees to the Caucasus. In this genus the horns are small, almost vertical, hooked backwards and downwards at the tips. The nose is hairy, there are no suborbital glands, but there are two glandular sacs behind the horns. The chamois is of small size, about three feet in length,

and two feet six inches high at the shoulder. The coat is of coarse brownish-red hair, darkening considerably in the winter. At one time common in the Swiss Alps, it is now somewhat rare, but herds of thirty to fifty are not uncommon in the various mountainous districts of Austria, where they are better preserved.

The herds are composed of females and young animals, the old males leading a more or less solitary life. At the approach of danger a whistling signal is given by the female on the watch, accompanied by stamping of the fore-foot. Their feats in swift-



FIG. 165. — *Rupicapra rupicapra*, chamois.

ness, when startled off, and especially in climbing precipitous places, where there appears to be no foothold, are celebrated by all Alpine hunters, and they appear to be able to throw themselves down declivitous places without hurting themselves. The rutting time is the end of November, and the female carries her young till the following May. Hybrids between chamois and goat are not uncommon, the horns of such hybrids presenting a curious intermediate form. Four-horned chamois are recorded from time to time, recalling the normal state of the *Tetraceros*, mentioned above, and certain abnormal conditions met with in sheep.

The twelfth sub-family (Nemorhedinæ) is represented on the American continent

by the Rocky Mountain goat (*Haplocerus americanus*), as well as by old world forms which have their headquarters in the Himalayas, but extend to China on the one hand and Sumatra on the other. The Sumatran form, (*Nemorhedus* [*Capricornis*] *sumatrensis*) has been recently described by Bock, in his "Head-hunters of Borneo." It is the Kambing-utan of the Malays. In form and outline it is something like a young reindeer: the coat is jet black, with a grayish mane; the ears are long and erect, the horns straight, with smooth apex, but furrowed and annulated half way up from the base. A suborbital gland is present, which discharges its secretion when the animal is irritated. The mountain-antelope acquires a goat-like beard when old. The natives catch this antelope in nooses of strong fibre, its flesh being sought after as preferable to that of the tame goat. The commonest Indian species is the Goral (*N. goral*), of about the size of a chamois, the habits and climbing powers of which it appears to share.

The remaining genus of this sub-family, *Haplocerus*, includes only a single species, the Mountain Goat (*H. montanus*), which is confined to the Rocky Mountains and California. Being an excellent climber it is found in the loftiest and most inaccessible peaks of these mountainous tracts, and is rarely disturbed by hunters, for it is excessively shy, and is not valued for its flesh. Of the size of an ordinary sheep, it nevertheless differs from them, and resembles the other members of the sub-family in having a distinct hump upon the withers. The shining black horns are from six to eight inches long, and project slightly backwards. The coat is of long snow-white hair, which is elongated on the throat into a beard; whence the ordinary name of mountain goat. Like other animals living under similar conditions they descend to lower levels during the winter time. The young are dropped in June.

The last sub-family (Caprinæ) of the Bovidæ embraces the sheep, goats, and the remarkable musk-ox (*Ovibos*). The generic name *Capra* is occasionally made to include both the sheep and goats, and, indeed, it is very hard to find distinguishing characters that hold good throughout, if we separate the sheep under *Ovis* and the goats under *Capra*. For instance, the characteristic rank smell of the latter is absent in some forms. They occasionally possess the interdigital glands, which were at one time thought to be confined to sheep, and above all, goats and sheep are perfectly fertile with each other. For purposes of convenience, however, we shall employ the separation into two genera, *Ovis* and *Capra*.

Compared with most of the preceding sub-families the body is smaller: the horns are directed backwards or laterally, and are more or less compressed, angular, and corrugated. The point of the snout is hairy, a naked spot between the nostrils being rare. The molar teeth are destitute of the accessory columns of enamel; the dew-claws are short and rounded, and as a rule there are only two developed teats.

As is also the case with the domesticated cattle our sheep (*Ovis aries*) do not represent any particular species but a whole series of races, the original sources of which it would be very difficult to determine. In all the wild forms the horns of the rams are exceedingly strong and heavy, and present three curves (basal, ascending; median, descending; and terminal, varying in direction) and three surfaces, named from their direction at their origin, frontal, orbital, and nuchal, the planes of which are, however, altered by the above-mentioned curves, and by twists in the axis of the horns. The transverse is the greatest diameter of the horns at the base: the forehead is flat, there is no beard, the muffle is entirely hairy. The hoofs are lower behind, and there are generally suborbital and interdigital glands.

Sir Victor Brooke regards the Himalayas as the birthplace of the wild sheep; of these eleven species are recognized, some of which are very imperfectly known. The most outlying forms geographically can be traced by intermediate forms to the central argalis (*Ovis ammon*). For instance, on the west *O. musimon*, of Corsica and Sardinia, and *O. ophion*, of Cyprus, are very closely allied to *O. gmelini* or *orientalis*, of Asia Minor; it again resembles *O. vignei*, from the mountains south of the Caspian Sea. *Ovis poli* and *O. karelini* are intermediate, both geographically and zoologically, between that form and the argali. Again, on the east the big-horn of the Rocky Mountains, *O. montana*, is most closely allied to *O. nivicola* of Kamtschatka, whose range approaches that of the argali.

Before discussing the domesticated races we shall glance at the more important wild forms in the order mentioned.

The wild sheep of Asia Minor, *O. gmelini*, may be taken as the type of the more westerly forms, taking the Himalayas as the geographical centre of the group. It is a very graceful sheep, deer-like in its appearance, owing to the length of its legs. It is common in certain districts of Asia Minor, especially near salt lakes, and ranges thence east and north to Kurdistan and Armenia. The general color is from reddish-yellow to muddy brown, darker along the dorsal line, but white on belly and under parts of legs. The height at the shoulder is twenty-two inches.

The two best known species inhabiting the high plateaus of Turkestan, *Ovis karelini* and *O. poli*, have been studied and described by Severtzoff. Unlike goats, which are satisfied with small tufts of grass growing in clefts of the rocks, these sheep require more extensive feeding-grounds, and are more easily driven from them by the hunters. They occur at great heights, up to ten thousand feet and more, but descend to a certain extent during the winter. *Ovis poli* has grayish-brown sides, with white belly and anal disk, is forty-six inches high, and its horns are fifty-seven inches in length. It has frequently been confused with the argali, *Ovis ammon*, which, however, does not occur in Turkistan, is reddish-brown, and has no white disk around the tail. Its range is of great extent, but of still uncertain boundaries; it is known to be most abundant in the mountains to the east and south of the Desert of Gobi.

The Nayanur, of Nepaul and Thibet, *O. hodgsonii*, is characterized by a snow-white ruff on the under surface of the neck, and a dorsal mane as far back as the shoulders, of somewhat shorter hair, as well as by its shorter horns, of which the terminal curve is not much developed. *O. nivicola* has by some naturalists been considered identical with the big-horn, to which it is allied, but its broad and short skull is sufficient to distinguish it from all other species. Its horns are very similar to the big-horn's; it has no mane, the whole hairy covering being long and woolly, of a grizzly-brown color, except round the muzzle, lips, rump, posterior part of the haunches, centre of the belly, and posterior surface of the limbs, which are pure white. The height at the shoulder is thirty-seven inches, length of horns thirty-three inches. *O. nivicola* is not confined to Kamtschatka, but occurs also in the Stanovoi mountains and in the Sywerma mountains, eastward from the Yenisei.

Our next form is the allied Big-horn of the Rocky Mountains. A glance at the figure will show how the horns differ from those of the argali; their terminal curves are much shorter, they are by no means so much compressed, and the wrinkles in the surface are not so distinct. The horns of the female are similar to a goat's, forming merely a simple curve, and are much lighter. The coat appears to vary in character at different times of the year. When the heights at which they occur are accessible,

the coat is more hairy, but in winter, when they are not so frequently observed, a fine gray wool is intermixed with the hair, and shed at the approach of the warm season. They are best approached by stalking from higher levels than those on which they are found: they do not appear to apprehend danger from above, and the nature of the ground affords no cover to the hunter.

The range of the big-horn is very extensive, for it has been found from southern California to Alaska, although it is probably most abundant in New Mexico and Arizona. It is not confined to mountains, for the Bad Lands of the White river, Little Missouri, Yellowstone, etc., also afford it a suitable abode. It appears to require



FIG. 166. — *Ovis montana*, big-horn.

but little water, for in many parts of Sonora no water is accessible except what is to be found in rain-pools. The old rams form small groups by themselves, while females, younger males, and lambs are found in herds of from five to twenty. The flesh is excellent, that of the lambs being particularly tender and juicy. An adult ram weighs about three hundred and fifty pounds.

The lambs are dropped in March, and the rutting season is in December, when the horns are often terribly battered, a condition which was formerly attributed to a supposed habit of the big-horn (and also of the European ibexes) of flinging itself over precipitous places if pursued, and lighting safely on the horns! But the females are just as good climbers and jumpers as the males, and the feet are the parts we have to look to as specially securing the nimbleness so characteristic of the animal.

The Maned Sheep of the Atlas Mountains (*O. tragelaphus*) is the chief stumbling-block to the sharp separation of the genera *Ovis* and *Capra*, for it possesses certain decidedly hircine peculiarities, such as the want of the suborbital gland, and the small development of the horns. Its general coloring is reddish brown, with a dorsal dark stripe. The fleece of curly wool is everywhere of much the same thickness, but on the neck and shoulders there is a short mane, and on the throat, front part of the belly, and outer side of the fore-legs there hangs down a regular curtain of strong coarse hair. The adult male stands some three feet high at the shoulder, with an extreme length of six feet, inclusive of the bushy tail, which is ten inches long.

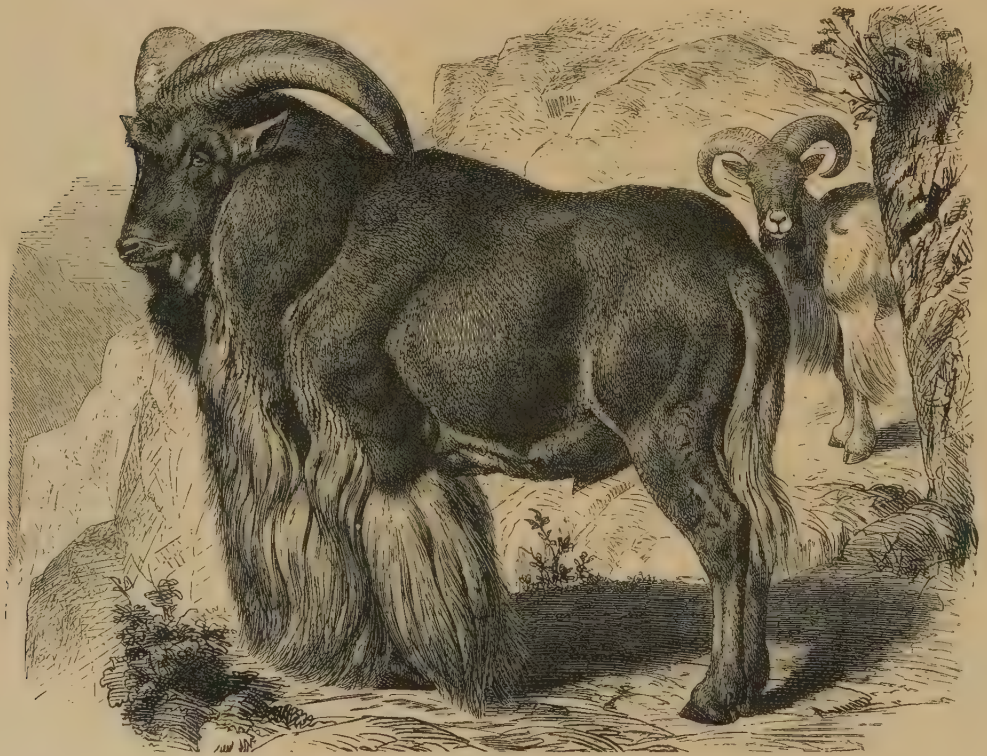


FIG. 167. — *Ovis tragelaphus*, maned sheep.

Passing to the domestic sheep two considerations force themselves on our attention, the influence of the long period of their domestication, and the tendency to vary and to effect fertile crosses which is to be observed even in the wild forms. These must be regarded as affording an explanation of the very numerous distinct breeds that exist, and also of the fact that the origin of these is very obscure.

Probably more than one of the existing wild species have had something to do with the production of existing breeds, and it is also likely that the progenitors of many of these are extinct.

The original color of the domesticated breeds was probably black or brown, and a frequent reversion to this is seen in most breeds,—just as in some of the hornless breeds, like the South-downs, a reversion to a horned state is often observed. The tendency to variation, and the production of abnormalities, which would be of more than

generic importance in non-domesticated animals, are set off by the obstinacy with which these characters are transmitted and retained. Thus in a sub-Himalayan breed, the Cágias, four teats are normally present; again another Indian breed is invariably characterized by the possession of four horns. The ears and tail are much reduced in size in the Chinese sheep, and the tail is loaded with fat in the so-called Turkish sheep of Asia Minor, Syria, and Arabia (*O. aries steatopyga*), to such an extent that the tail, the oil from which is much valued, is occasionally carried on a truck. These forms again have drooping ears, a sign that the species must have been subjected to long domestication.

Speaking of the suddenness with which new breeds may originate, Darwin records the case of a ram lamb born in Massachusetts in 1791 having short crooked legs, and a long back, which gave rise to an *otter* or *ancon* breed incapable of leaping. This breed has since been replaced by merinos and exterminated, but in crossing with other sheep the offspring were always perfect in resemblance to either parent, so that by selection a breed of this semi-monstrous character could have been very quickly originated. So the Mauchamp variety of the merino sheep, celebrated for the silky character of the wool, is of like sudden origin.

In the above-mentioned breed there is decided correlation between the fineness of the wool and the slender character of the horns, and this is also very frequently observed in other breeds. It is hard to say exactly what conditions will alter the fleece, but a change of pasture has been noticed to make a considerable difference. In the wild forms it may be taken as a general rule that in the warmer countries the hair is developed at the expense of the wool, but this does not hold good for the domesticated forms, because very fine wool is derived from the sheep of tropical countries. That pasturage has much effect on other peculiarities besides the fleece is beyond doubt. Pallas asserted that the sheep of the Black Sea district owe the cushions of fat on the haunches to the saline plants of that regions.

A race occurs in Persia to the north of the Caspian with coarse, hairy, gray wool, which is perhaps nearer to the Argali than any other domesticated form. This race is widely diffused in Persia and India. The Astrakhan sheep yield a valued fur; this, however, according to Professor Low, is taken from the lambs before their natural birth.

The sheep of the Slavonic races resemble those of Scandinavia and the northern parts of the British Isles in having short, flat tails, and coarse hair intermingled with the wool, but in Shetland the latter is very fine in spite of the coarse admixture.

In the breeds of Southern Europe the tail is long without being fat, and the wool generally finer. Of these the Spanish Merino breed (*O. aries*, var. *hispanica*) is justly celebrated for the very fine wool it produces. The fineness of the wool has been attributed to importation of different breeds and careful selection of the different conquering races that have successively dominated that country. Most of the British breeds are of the long-tailed varieties, many of them having been improved by judicious crossing with the merino breed.

In comparison with the sheep, the goats (genus *Capra*) have horns the greatest diameter of the bases of which is not from side to side but from before backwards, with transverse projections which leave the inner sides smooth. The forehead is convex, and there is only a very small bare spot between the nostrils. The chin is generally bearded, the tail short and upright. The wild goats are as numerous in species as the wild sheep, and are generally subdivided into ibexes and goats proper,

the horns of the former sub-genus being destitute of the keel in front so characteristic of the latter.

We figure two species of the former group, the Alpine and Pyrenean Ibexes (*C. ibex* and *C. pyrenaica*). These are the only European species, but forms are known from the Caucasus, Mount Sinai, Siberia, and Kashmir. The Alpine Ibex, or "Steinbock," is about four feet six inches in extreme length, over thirty inches high at the shoulder, and may weigh up to two hundred pounds. The horns, which are very close at their



FIG. 168.—*Ovis aries*, var. *hispanica*, merino.

origin, diverge backwards and outwards to their tips, which are curved downwards. The so-called rings of growth project most towards the middle of the horn, which in the male may attain a length of three feet on the curves. The horns of the female resemble those of the domestic goat. The coloring, which is reddish gray in summer, becomes dead-gray in winter. The ibex appears to be nearly extirpated except in the mountainous tracts between Piedmont and Savoy, where, for example in the Cogne and Savarauche valleys, they are exclusively reserved for and protected by the King of Italy. The males are always found on higher levels than the females and young, and except in January, the rutting time, are found solitary. The hunt of the ibex is as difficult as that of the chamois; the scent of the latter is no doubt more acute but the



Capra ibex, Alpine ibex.

sight of the ibex is on the other hand sharper. They are thoroughly fertile with domestic goats, which, according to some naturalists, owe some of their peculiarities to an intermixture of ibex blood.

The Pyrenean ibex, abundant in the Sierra Nevada of southern Spain, is of similar size, but the horns diverge more from each other, and finally point inward at the tips. The rings of growth are not so distinct as in the Alpine form. The winter coat is more



FIG. 169. — *Capra pyrenaica*, Pyrenean ibex.

abundant and not so bright as the summer, which is brownish admixed with black in mane and beard, but paler and even white on the under parts.

The type form of the sub-genus *Hircus* is the Bezoar goat (*Capra aegagrus*) of the Caucasus and Persian mountains. This species appears to be entirely confined to Western Asia and certain islands of the Ægean. In Crete, it is found on the slopes of Mount Ida up to 8,000 feet. Its range in Asia is from Sind through Persia to Asia Minor, the eastern forms presenting varietal differences from the western. It is sometimes known as the bezoar goat from the concretions or bezoar stones

(formed of various lime-salts round some indigestible substance as a nucleus) which are found in the stomach, and were supposed to have great virtues as antidotes to poisons. According to Danvers the wild goat occurs in Asia Minor either solitary or in small herds of thirty or more. It is shy except during the rutting season, parties being always led by the oldest male when danger is suspected. The young are dropped in May to the number of one or two. The females are quite beardless; their horns are much smaller than those of the male, about twelve inches long, while three and



FIG. 170. — *Capra hircus*, var. *angorensis*, angora.

even four feet are recorded for the male. The points of the horns are turned inward to a greater or less extent; like some antelopes' they appear to be the seat of larvæ of a species of botfly (*Æstrus*) which makes its way inwards through the frontal sinuses.

Many naturalists agree in considering *C. ægagrus* to be the original stock of the tame breeds of goats. Sundevall, however, thought that *C. falconeri* from Thibet and Cashmere comes nearer to the domestic goat. Danford is of opinion that the *ægagrus* is the principal stock of the western breeds, but that the presence of a beard in the tame females, as well as the tendency to a flattened and spiral form of the horns

in both sexes, indicates some admixture with the European ibexes. *C. falconeri*, referred to above, is especially distinguished from its congeners by the long spiral horns, and the abundant hair on the chin, shoulders, and throat.

The same circumstances which have produced so many races of oxen and sheep have also given rise to the various breeds of the domestic goat, which are marked by differences in texture and color of the coat, and in the occurrence and shape of the horns. The central Asiatic goats, living in a climate subjected to great extremes of temperature, furnish the excessively fine wool of Cashmere and Thibet, which is formed to keep them warm during the cold season. Again the Angora goat of Asia Minor furnishes long silky hair, which is of great commercial importance. In all countries the leather is valued, that of Morocco being especially fine and durable; the



FIG. 171. — *Ovibos moschatus*, musk ox.

skin of the kids is also everywhere in demand for the manufacture of gloves. The flesh of the adults is ill-flavored, but that of the kid, especially in eastern countries, is much appreciated. It is chiefly for dairy purposes that goats can now in this country be regarded as of economic value. The goat supplies abundance of milk, especially rich in the caseous elements that furnish cheese, and requires much less dainty food than the cow or the ewe, so that it is deserving of being more generally introduced than it is at present.

The last genus of the Bovine family is the singular Musk Sheep or Musk Ox of the polar regions (*Ovibos moschatus*), which is occasionally regarded as more closely allied to the oxen than might be inferred from the position in which we discuss it here. It is now confined to Arctic America north of lat. 60°, but its remains are found in Siberia, Germany, France, and England, so that its present distribution is much more restricted than its past. The important generic characters are the following:—

The point of the snout is hairy, there being only a small naked spot between the nostrils; the upper lip is not furrowed. The forehead is flat, the broad bases of the horns meeting in the middle line, their general curvature downwards but the tips bent upwards. The tail is short and concealed by the long hairy coat. The whole length is about eight feet, the height at the shoulder over three feet. The general coloring is dark amber, which is darker on the face, shoulders, and sides, where the long hair is more abundant, but paler where, as on the back, the wool predominates. The wool is very fine, and is employed by the Eskimos for various textile purposes. The abundant hairy coat is cast during the warm season, the animal appearing to have great difficulty in getting rid of it on account of its thickness.

The odor of musk, to which the *Ovibos* owes its specific name, appears to be persistent in the flesh of the old males in the rutting season, but does not render that of the females at all unpalatable. None of those killed by the members of the Polaris expedition had a very marked musk smell. No difficulty was found in distinguishing the tracks of these animals from those of reindeer, although some former observers have not found this easy. In all the herds there are from ten to twenty females to one male. Their whine is somewhat like the snorting of the walrus, and never resembles in the least the cry of the goat or the shéep. When danger approaches stationed sentinels give signals by stamping or striking their neighbor with their horns. They have dire combats with each other at the rutting season, and with bears sometimes, in which they often come off victorious. The rutting time is in August in northern latitudes, but somewhat later in more southern localities, and the females carry their young nine months. The lamb is unable to follow its mother for three or four weeks, during which time it is concealed and protected by the mother.

The favorite haunts of the musk sheep are about Great Bear and Great Slave Lakes and along the upper tributaries of the Mackenzie River. Parker Gilmore says that the flesh is excellent and nutritious when fat, but quite the reverse when by a long and protracted winter they become thin and attenuated. The flavor is much the same as that of venison although much coarser in the grain. A full-grown male attains a weight of four hundred and fifty pounds, the female from fifty to seventy-five pounds less. Although so unwieldy in form the musk sheep are very nimble, making for the roughest ground when pursued. The food consists chiefly of various mosses, grasses, and leaves of brushwood.

R. RAMSAY WRIGHT.

ORDER XI. — CARNIVORA.

The cats, dogs, bears, and seals, and their allies are all flesh-eaters, and this fact in their alimentary economy has led to their ordinal designation Carnivora. They are the beasts of prey, and their organization is in accordance with their mode of life. Not only is their structure affected, but their mental system as well shows the results of their predatory habits.

Ignoring for the present the exceptions found in the aberrant group of seals we may say that the skeleton does not present as many variations from what may be called the typical form, as does the bony framework of many other of the groups. The bones are comparatively slender, but they are nevertheless very strong, features of no small importance in animals with their habits. As a rule, there are thirteen dorsal vertebrae present; the clavicles are imperfect or rudimentary, and the feet are usually five-toed. To this latter statement there are to be noted the exceptions that in some cases, for instance, the dogs and cats, the toes may be less in number. These toes are always armed with claws, and a further character is that the thumb or great toe cannot be so opposed to the others as to render it possible for the animal to grasp any object.

In the skull we find several characteristic features. The jaws are short and stout, and on the walls of the cranium are prominent ridges for the attachment of the strong jaw-muscles. In many other forms, especially in the rodents and the ungulates, the lower jaw is so connected to the skull as to allow considerable motion in the mastication of food; but in the carnivores the head of the lower jaw is usually placed in a deep and narrow socket so that comparatively little grinding motion is possible, the movements of the jaw being confined to a vertical plane. The teeth are also adapted to the food, and we miss the complicated patterns of enamel and dentine so universal in the herbivorous ungulates and rodents. The

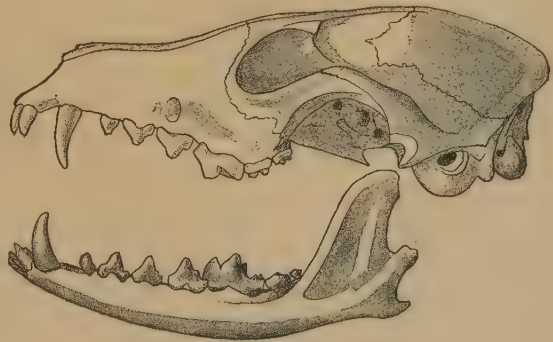


FIG. 172. — Skull of red fox.

teeth are entirely covered with enamel, and are fitted for cutting rather than for grinding. Incisors, canines, premolars, and molars are present. The incisors are six in number in each jaw, the lateral ones being the largest; the canines are strong and conical, and sometimes acquire an enormous development, which reached its culmination in the extinct sabre-toothed tigers. The typical number of premolars is four, and of true molars three, in each side of each jaw, but variations from these numbers are common. One of the molars or premolars in each side of each jaw is usually converted into a 'sectorial tooth.' This tooth has a compressed cutting edge which, meeting its fellow of the opposite jaw, acts like a pair of shears.

In accordance with the easily digested food we find the alimentary tract correspondingly shortened and simplified. In the lion it is only about three, in the hyæna

eight, and in the seals nearly twenty times the length of the body; but in the latter forms the canal is very narrow, and the surface is of course proportionately reduced. The cæcum, when present (in digitigrades), is small and smooth; the vermiform appendix is never found. In many forms are well-marked anal glands which produce a strong-smelling, defensive secretion most familiar in that of the skunk.

The cerebral and olfactory lobes are large, and the senses, with the possible exception of taste, are highly developed, as would be expected in animals with their intelligence and activity. The great majority live upon the products of the chase, and the one which possesses the greater cunning and the more acute senses stands the best chance in the struggle for existence.

The Carnivora are divided into two sub-orders, the Pinnipedia and the Fissipedia. The former group is undoubtedly the lower, but as it is at the same time the most divergent from the type, we will begin our treatment with the Fissipedia, and subsequently take up the seals and their allies.

The fossil history of the carnivores has not been made out with that certainty and to the same extent as that of the ungulates. Our living forms seem to be distinct but exhibit many points of resemblance to the insectivores and marsupials. When we study the fossil forms two more orders are brought into view, the ungulates and the primates. The genera *Mesonyx* and *Synoplotherium* are apparently representatives of the ancestors of our present carnivores, and through the latter the group is connected with the insectivores. Through some form, like *Nasua*, this order is also connected with the ungulates, and with the primates by extinct forms like *Notharctus* and *Tomitherium*, and the connection with the higher group is rendered even more close by the genus *Cercoleptes*, which has quadrumanous teeth and jaws combined with characters of the plantigrade carnivores.

The ancestor of all was a plantigrade with tubercular molars, but the flattening and partial coalescence of the outer tubercles, and the entire loss of the inner, has resulted in the formation of the sectorials of our present forms, while a corresponding modification of the feet in some of the forms has resulted in the specialized digitigrades.

SUB-ORDER I. — FISSIPEDIA.

The split-foot or split-toed carnivores have the limbs adapted for walking, and the body fitted for a terrestrial life. The sub-order is divided into three super-families, of which the bear, the dog, and the cat may be taken as the respective types. In the first the majority of the forms walk upon the sole of the foot, and hence are known as plantigrades, while most of the other groups walk on the ends of the toes, and have been called digitigrades. But as these terms are not strictly applicable, nor in accordance with the most approved classification, they have been replaced with those employed below.

SUPER-FAMILY I. — ARCTOIDEA.

Under the term Arctoidea have been grouped an assemblage of animals possessing in their physiology and osteology more or less bear-like characters and affinities. To the ordinary observer the most easily apparent of these would be the plantigradal structure of the feet. The literal meaning of the term Arctoidea is "bear-like," and as the name of a great family or group, it at once suggests the bear as its typical or representative animal. Every one knows that Bruin on his travels "comes down flat-

footed." But very different from this flat, heavy travel of the plantigrade is that of the light toe-stepper, the digitigrade dog and cat.

But this peculiarity of the feet is not equally pronounced throughout the entire group. The anatomy looks to other particulars also, notably the structure of the head and teeth, and correspondingly to that of the alimentary canal. However rapacious, to a remarkable degree the Arctoidea have adaptations for an omnivorous diet. There is, too, the *tout ensemble* of an animal—the individual totality. Now outside of scientific methods there is often found the scientific instinct, which truly notes resemblances that it cannot define. This unconscious divination has in it a touch of genius. We have heard such call the raccoon the tree-bear. As already stated the true bear, *Ursus*, is the representative animal of the group now under consideration. And it is happily so. In rank and social estate a king does not represent but heads a nation. The prince and the peasant may show the extremes, but only one of the middle class can fairly represent the people. So it is with Bruin; he is neither the lowest nor the highest, but is actually a "middle-man" in his tribe. It will be convenient then, and not at all arbitrary, but quite natural, to divide our group Arctoidea into three sections. Keeping in mind the meaning of arctoid, which is bear-like, let us begin with the lowest in the group. Then our first sub-section will be the raccoon arctoids, or coon-bears. The second sub-division will be the typical arctoids, or true bears, the Ursidæ. The third sub-section will give us the Mustela arctoids, or weasel-bears. We shall find in this third sub-section a rapid advance towards a higher group, for at the bottom of this third division will be found the sub-plantigrade, in the middle of the section the plantigrade, and at the top the digitigrade, which with its higher development crowns the entire group of the Arctoidea.

As already stated the lowest in rank of the Arctoidea, or bear-like mammals, is the sub-section coon-bears, which have two true molars in both jaws, and a well-developed tail. First in this section comes the family BASSARIDIDÆ, which contains but one genus, *Bassaris*, with but two species. It is characterized by the presence of four premolars and two true molars in each side of each jaw, the last premolar of the upper and the first molar of the lower jaw being sectorial. Formerly *Bassaris* was regarded by the systematists as an American civet. In time its right to a place among the true civets was disputed. Some authors believed it to have affinities with both the civets and the weasels. Says Allen, "Others . . . have hinted at an ursine alliance, especially to such forms as *Procyon* and *Nasua*. Professor Flower, who has especially investigated the affinities of *Bassaris*, concludes, 'On the whole I think there can be little question that evidence has been adduced to prove that *Bassaris* is a member of the arctoid sub-division of the Carnivora, and among these approaches most nearly to *Procyon* and *Nasua*.'" Indeed even to the superficial observer *Bassaris* is quite suggestive of relationships. To one who has seen the coati-mundi there seems, from the long, ringed tail, a leaning in that direction. To one who is accustomed to seeing foxes and coons a vulpine cousinship is recognized in the short head, pointed muzzle, and clean-cut, projecting ears, while its bushy, ringed tail also points to the raccoon; hence in California it is often called the raccoon-fox. It would seem, too, that after all, the first specimen described suggested in this very way the generic and specific name to the describer, for Lichtenstein's name, *Bassaris astuta*, means a cunning fox. His specimens were probably from the north of Mexico. Allen tells us the Mexican names are Caca-mixtli and Tepe-maxtla, meaning respectively rush cat and bush cat.

The number of popular names which *Bassaris* bears in English is not less than a dozen.

It was supposed that *Bassaris* was limited to the warm regions of Mexico, and some not considerable distance north and south of that country. But in February, 1872, one was captured in Ohio, and in 1877 another was trapped some thirty-five miles northwest of Jacksonville in Oregon. Says J. Sullivant, who announced the discovery of the Ohio specimen, "The little animal measured thirty-two inches from the end of its nose to the tip of the tail. The body was sixteen and one half, and the tail fifteen and one half inches in length. It stood about seven inches high. The tail had sixteen rings, alternately black and white." This was *B. astuta*. Of this species another author gives these markings: "The color is a light uniform dun, with a dark bar like a collar over the back of the neck. In some specimens this bar is double, and in all it is so narrow that when the animal throws its head backwards the dark line is lost in the lighter fur. Along the back runs a broad, singular, darkish stripe. The tail is ringed something like that of the ringed lemur, and is very full."



FIG. 173. — *Bassaris astuta*, racoon-fox.

This animal subsists on small birds, mammals, and insects. It is often tamed in Mexico, and is a favorite pet with our miners in California. It has at least four young ones at a litter.

There are two species, *B. astuta*, the so-called southern species, and *B. sumichrasti*, the assumed northern one. Both species, however, have been found in Mexico, though the former greatly outnumbers the latter.

Generically the points given by Allen are: In general appearance they are small, fox-like animals, with soft, loose pelage, pointed nose and ears, and a ringed tail as long as the body, giving a *tout ensemble* intermediate between the coatis and raccoons on the one hand, and the foxes on the other, but of smaller size than either. The females are much smaller than the males.

This is not the place for the minutæ of specific distinction. We can only say that of *B. astuta* the ears are rather narrow and pointed; soles and palms with short, soft hair on the edges, and at the base of the toes between the naked pads: upper surface of the feet slightly or not at all blackish. In *B. sumichrasti* the ears are broader and

shorter and less pointed; soles and palms totally naked; upper surface of the feet black or blackish, and the general color of the dorsal surface usually darker than in *B. astuta*. This species, too, has a character in the incisors not found in *B. astuta*, namely, a trilobed border to these teeth, which Cordero refers to as having "la figura de una flor de lis." Sumichrast's *Bassar*i, too, is considerably the larger animal, and yet it has the smaller ears. They are broader, less pointed, and about one fifth shorter than those of *B. astuta*.

It is a pity that so little is known of the biography of *Bassar*i. The fact that it is so often tamed would indicate that it is a "cunning little fox" in an amiable sense. But we have not been told much about its winsome ways. In nature it is a dweller in the woods, making a moss-lined nest in a hollow tree. It has a habit of gnawing the wood round the entrance of the hole, so that its retreat is betrayed by the chips which lie on the ground close to the tree. It often grows bold and enters the miner's tent, and plunders his provision bag, thus sometimes getting caught. It is easily tamed, and becomes so familiar and entertaining that it does much to soften the asperities and relieve the monotony of the miner's life. To him it becomes a plaything, and its merry kitten-ways make it almost companionable. Hence little wonder that an attachment springs up such as causes the miner to put on his pet an almost fabulous price. In Mexico, where it is often tamed, it repays all kindness by keeping the house clear of mice. The life of *Bassar*i is yet to be written. So far the chief concern about this pretty, curious little animal has been expended on its heteroclit character structurally, which has severely taxed the sagacity of the best systematists.

The next family is PROCYONIDÆ, the raccoons, embracing the animals well known by that name, also the coati-mondis of South America. The teeth are the same as in the last family, except that the last premolar of the upper and the first molar of the lower jaw are tubercular. The family very naturally divides into two sub-families, the Procyoninæ, the coons proper, and the Nasuinæ, or coaties.

Procyon lotor is the animal so famous as the object of the coon hunt, in which nocturnal sport, for valid reasons, the negroes of the United States have always been especially conspicuous. This raccoon is found in all the wooded portions of the Union. Fully grown it measures about two feet from tip of nose to base of tail; the latter organ is from ten to twelve inches long to the end of the hair. The dense gray pelage is mixed with black. The long coarse hair covers a soft fur. The tail is ringed with whitish and black alternately. The body is stout, head broad, muzzle pointed, and ears rather large. The coon's bill of fare is so extensive as to make the animal a nuisance to the farmer. It eats almost everything. It can upon occasion even fish. Frogs, birds, and their eggs are eagerly sought and adroitly taken. These failing, the hen-roost is visited, and for variety the gardens and the fields. It is said to open a pumpkin and eat the seeds. The sweet milk in the kernels of green corn is eagerly sought, and it will do much mischief in the cornfields, bending down the stalks and gnawing on the ears in a provokingly wasteful way, so unlike that of the musk-rat, which gnaws off the ear and carries it to its home. Hence the sight to the farmer on a morning of the coon's large tracks is not welcome.

Our northern raccoon is known among naturalists as *Procyon lotor*, the specific name meaning the 'washer.' In Germany it is called 'the washing bear.' The animal has a most unsightly habit of subjecting its food to a water bath upon every occasion, reminding the writer of a fastidious person who was so cleanly that she was

called dirty. She had a nose for uncleanness. The primest cut of beef was for her unfit to be eaten until it had been sodden and drenched in many waters, and made as colorless as the flesh of fish. So with the coon, especially if it have animal food; even an oyster, of which it is very fond, must be doused in water until it becomes almost shreddy. Some say this is due to the animal's sense of cleanliness. Nonsense. Others think it is to soften its food. Does an oyster need softening? Besides *Procyon* is



FIG. 174. — *Procyon lotor*, raccoon.

well supplied with good stout teeth. Of these it has forty, only two less than the bear. And the molars have tuberculated crowns, which, though not well suited for grinding or mincing, are admirable for crushing. As to its two somewhat outstanding canines they are double-edged and sharp, cutting keenly, of which the writer has had very convincing experience. We think that the habit of washing its flesh food is due to a lutrine proclivity or instinct. It can catch fish, but not in the way nor with the ease of the otter. This dousing of its flesh food in water is a curious gastro-

nostic propensity, imparting to its dietary, though it be by delusion, a smack of the taste of fish, of which it is so fond, but which it is hard for it to obtain.

As illustrating the cunning of the coon a teacher of zoology informed his class that the raccoon would lay in wait by an oyster-bed, and when the oyster opened its shell the coon would insert a paw and snatch the mollusk out. How strange that such a statement should have any credence. The raccoon does like oysters, and the musk-rat likes river mussels, and, however it is done, both animals have a way of their own for opening the bivalves. The coon makes much use of his pointed, flexible muzzle in getting worms and grubs out of nooks and narrow places. Where this fails the cunning fellow makes good use of his paws. He will vary his efforts, if necessary, putting his body into position and introducing the paw sidewise. Thus he will explore the nest of the golden-winged woodpecker in its deeply excavated hole in the apple tree, inserting his paw and extracting the eggs, and sometimes drawing up the poor bird itself. "It watches turtles when depositing their eggs in the sand, and upon their departure digs them up." So says Kennicott. That the raccoon has a sort of skill of its own cannot be doubted. A friend was hunting in the Adirondacks and the party encamped for the night. The camp was the ordinary shed or booth with an open front, which was well protected by a fire. In the night a raccoon managed to remove a portion of the bark roof and make off with a piece of bacon without disturbing the sleeping hunters, who did not discover their loss before morning.

That the reader may know something of the inner life of this fine animal we must give an account of a tame raccoon known in our neighborhood as "Coon Dick." As nearly as we can we will give it in the owner's words:—

"When I was a boy on one occasion my father sent me to turn the hay in the meadow. I was going to my work carrying the hay fork in my hand when on nearing a swamp I heard a curious noise, and on looking saw a young coon running along the bank of the stream. It would run in one direction and then turn and run back again, repeating the movement, and all the time keeping up a whimpering cry, which is not easy to describe, but which seemed to indicate that it wanted something. I thought that it wanted to cross the stream. With the pitchfork in my hand I gave it a toss which caused it to fall off the bank into the stream. I was tempted to spear it, but taking pity on the poor thing I helped it out of the water. To my surprise instead of running away it came directly to me. So I took it up into my arms, and scratching its head and talking to it in a fondling way, I carried it home. It became at once a great pet, for it seemed to have an implicit confidence in me, and I own to having had quite an affection for it. Still this very confidence made it a little too fearless, and it would get in the way. I chained it up. But this loss of liberty was a new and painful experience. It began sulking, and for several days almost entirely refused food. During this time it had a curious habit of bending its head under the chest and between the fore-legs, bringing the weight of the forward part of the body upon its forehead, which rested on the ground. It seemed to sit upon its face. I would stir it up, and talk softly to it. 'Come, Dick, poor Dick!' Then I offered it food, which it refused. I then as if neglecting it thought best to wait patiently. The little prisoner still refused food for nearly three days. It was now keenly hungry, and I offered it food, which it took with a strong appetite. The matter was now accomplished. Dick had found his appetite, and in some degree had become reconciled to his chain. It knew me well, crying after me every time I came in sight. I would call, Dick, for it had

learned its name, and it would answer me in a plaintive but affectionate tone. I treated it in the matter of the chain much as one does a dog, sometimes giving it full freedom. At such times it would follow me all about, and to a great distance, sometimes even going with me to the woods. It would at these times climb trees. I would then call, Dick! Dick! and make a feint of running away from it, when it would come down and run after me. We had near the house a pool of cold water which was fed by a never-failing spring. It was our custom to put live fish in this pool, whence we took them when wanted for the table. To our regret Dick found this out. And he had a very foxy way of helping himself. In fact he was too fond of fish, and quite too clever at catching them. It was somewhat droll to see him waiting patiently at our little fish pond. When a fish would come near enough, with an extended paw it would give a sideway blow with the claws protruded and thus jerk or hook a fish so neatly out of the water. When I got Dick he was, I should think, about one third grown. He grew finely; in fact he was well fed. But he had a mussy way of dousing his food in his water. I caught him in June. In the fall on one occasion when he was not chained a man came to the house with his dog. Dick had scared other dogs, but this one was too much for him, and he took for the woods badly frightened. The dog left him up a tree. I don't know, but that seemed to break up his attachment for the house. He did come back a few times, but did not allow us to catch him. Soon his calls were made only at night, when he got visiting the chicken coop. Having now to feed himself he became a nuisance. He had become pretty big by this time, and it being late in the fall we never saw him again." It was our opinion that Dick had a preliminary family matter on hand, hence the wild nature was all revived.

The regular coon hunters have what is known as coon dogs. These sagacious beasts enjoy the moonlight hunt intensely, but sometimes the dog gets terribly worsted. The raccoon will throw itself on its back and will fight desperately. The dogs in these night hunts will sometimes get away a great distance from the hunter, and when they "tree a coon" will set up an incessant barking. The hunters will thus be drawn by the sound which sometimes is a full mile off. Frequently the treed coon is snugly sleeping at the bottom of the hollow in a tree. The party is provided with axes as well as guns, and with material for making a fire. A hole is cut at the supposed bottom of the hollow of the tree, and straw set on fire applied, which drives the coons out at the upper end. So thick is the animal's hair that it is often useless to shoot if its face is towards the hunter, as the shot will glance from the fur. The plan is to shoot from behind so that the shot may creep up the hair. If the desire is to capture the coon alive a bag is held over the egress towards which the smoke drives the animal. As many as from six to eight have been taken from one hollow tree but a few miles from our home.

As illustrating the cunning of the coon and the excitement of capturing him let us relate an incident. Near the residence of a tenant farmer was a large old tree which was hollow. A friend who was passing observed the nose of a coon basking in the sun just above the top of the hollow, and called to the tenant, "There's a coon in that tree." "Yes, sir, and he's been there several seasons, and as I am not allowed to cut the tree down he seems to defy me. I have set traps, and my dog has watched him, but he won't watch him any more; I think they have had a fight and he's got the worst of it. Well, I've shot him, and I know I've hit him, but it's all of no use, and the villain has several times got one of my chickens." To this our friend said, "We'll have a hunt to night, and I'll catch him." He was told that it would be of no use.

But he returned with two men and a ladder. A ball of cotton tied up compactly was fastened to a rope. The ball was soaked in kerosene oil. A man ascended the tree and, having seated himself astride a branch, he set fire to the ball, then lowered the blazing mass down into the deep retreat of the coon. This was a new enemy, and the disconcerted animal came with a rush to the top of the hole, and looked at the man with such a desperate gaze that he cried in fright, "He's coming for me." "Pull up your fire-ball, quick, and stick in his face," shouted the leader. This the man did, dousing the blazing mass into the animal's face, which caused it to fall heavily to the ground. The beast ran for the meadow, and the dog pursued. The raccoon had to stop to fight off the dog, which gave the men time to come up, and a club settled the business.

The fact must not be withheld that upon opportunity the coon becomes very intemperate. A publican in Nebraska had two tame coons, one, being the more gentle, was allowed wider freedom in the saloon. He acquired a craving appetite for strong drink, and became an adept in practice at the bar, for when he could not get beer as a gift he learned how to help himself. The miserable craving actually sharpened the animal's wits. He would stretch himself on his back under the tap of the beer barrel, put his paws on the stop-cock, and manage to turn it but a little, and so let the beer trickle into his mouth, until he had got his fill. If not caught the liquid would flow on the floor, for he did not know enough to stop the tap by turning it back. Intoxication would soon follow, and the conduct and quadrupedal stagger of the drunken coon were singularly grotesque. His companion never learned the trick, and so led a more virtuous life.

In the northern United States the raccoon, in the seclusion of some deserted burrow, or the hollow of a tree, or some similar retreat, goes into hibernation, but it is neither so profound nor so continuous as is that of the bear. It is said also to have, like the bear, the tapen or enteric plug, which, owing to its smaller size, is seldom seen. In describing the face of this animal, Kennicott says, "A black stripe extends across the face, producing a spectacle-like appearance, which, together with the animal's monkey-like movements, gives to its physiognomy a very comical expression." The animal walks on its toes, but stands on the soles of its feet. Its range is from British Columbia to Texas.

In the lore of the native woodmen of New Jersey the belief prevails that there are two species of coons, the tree coons and the bank coons, the former being the larger, and having blacker feet. There is but one species, but there is an interesting difference in habit. The one nests in the hollows of trees, the other in burrows made by itself in the sides of ditches and streams. These burrows have an egress as well as an entrance. Near us was a ditch with the bank thus burrowed. A friend dug into one of them, and took out two little coons, which cried "like little babies." They were restored, but put to the wrong hole; nothing could force them to enter it, so they were let alone, and at once sought and entered their own nest. The mother coon will bear from three to six little ones. They are born blind, and do not open their eyes until twenty or twenty-one days old.

Procyon hernandezii, the Black-footed Raccoon, sometimes called the Mexican Raccoon, is a southwestern species, and its home seems to be in California, Texas, and Mexico. It is somewhat larger, and, in general, the color is lighter. The habits probably are much the same. Says Baird, "This species bears a very close relationship to *P. lotor*, and without close comparison the differences are perhaps intangible."

The only other true raccoon known is the *Procyon cancrivorus*, the Crab-eater. In its own country, South America, it is called Agouara. It is somewhat larger than the North American species, but slimmer-looking, owing to its shorter fur. In truth it is not the fine handsome fellow that its cousin north of the equator is. As to the crab-eating propensities of the southern species, it should be said that in tropical climes, besides the water species, there are land crabs of large size and in great numbers. Were this so north, *lotor* would be as devoted a cancerite as his southern cousin *cancrivorus*.

The *Nasuinae* or Coatis are now in order, of which the one genus is *Nasua*. The muzzle of this animal is extended into a long cartilaginous snout of extraordinary flexibility or rigidity, as the will of its owner may dictate. It can be so reflexed as to bend upward and backward. It can be so stiffened as to serve for a plough with which to furrow the earth in quest of worms and insects precisely as do the swine. The pelage is generally of a warm color, from reddish brown to bright chestnut, and in the lower parts of the body in some instances toning up into a warm yellow, almost orange. But the colors are so diverse as to lead J. A. Allen to say, "Few of the terrestrial *Feræ* present a greater range of color-variation, wholly independent of sex and age, than do the species of coati." The pelage is quite thick and long. The tail is long, bushy, and ringed like the raccoon's, but more distinctly. Like the coon it is a most omnivorous feeder, eating and drinking everything in its way, not excepting whiskey and brandy, especially if sweetened. Its habits are largely arboreal, it being an admirable climber, and descending trees head first with perfect facility.

The two species of coati have received not less than thirty names from systematists. It is curious too that the old hunters both in Mexico and Brazil seem to be at fault, in each country two species being recognized which really in each case are but one. Prince Maximilian heard from the Brazilian hunters that they had two kinds of coati, one small and slender and associated in large companies; while the other was larger, less slender, and lived singly or in families; the first being termed by them Cuati de Bando, the second Cuati Mundeó. He therefore named the former *Nasua socialis*, and Cuati Mundeó he named *N. solitario*. Afterwards De Saussure recognized two species from Mexico under the two names of Maximilian, which the natives called Tejon de manada and Tejon solo. Hensel afterwards cleared up the error by showing its cause, which was due to age and sex. He says the old males live solitary, hence the name *N. solitaria*. "At a particular time of life, that is to say when the long canines begin to become worn, the old males leave the troops, of which, in company with the old and the young females, they had hitherto formed a part, and afterwards only run with them in the pairing season. . . . Solitary females are never met with, unless, perhaps, they have been driven from the herd in hunting them." For the above we are indebted to Allen who has done effective work in unravelling this terribly tangled skein of the systematists. There are only two species, one in Mexico and one in Brazil.

Nasua rufa, the Brazilian Coati, is somewhat the smaller in size of the two species, and its pelage though thick is harsh and coarse; the long hairs of the dorsal surface are usually black-tipped, the ears rather longer and more pointed than those of the other species. "The species appears to range over the greater part of the continent of South America, certainly from Surinam to Paraguay, and from the Atlantic coast to the Andes, over which extensive region it is one of the most abundant of the carnivorous mammals."



Nasua rufa, coati.



We now propose to give in some detail the true inwardness of a tame female red coati by condensing our account of the same in the *Popular Science Monthly*, November, 1872.

We called her Jack, sometimes "Nosie," but science had already named her *Nasua*, and in a matter-of-fact way, for the word interpreted means Nosie. The animal was about the size of a cat, with a thick, coarse fur, of a brownish hue on the back and sides, and underneath shades from yellow to orange. The long tail was ornamented by a series of black and yellowish-brown rings. To *Nasua* her nose was important. Inappeasably inquisitive, she was incessantly intruding that organ into every thing. Having made no allowance for an extra-tropical temperature, this little South American made a failure in an attempt to lift with her nose the lid of a pot in the cook's domain. It was enough that any thing was hollow to excite her curiosity, which was of a thoroughly simian type. The dinner-bell was turned over; but, unable to detach the clapper and chain, it was soon abandoned in disgust. A round sleigh-bell received more persevering attention. Unable to get her nose or paws into the little hole at the side, the clatter within set her wild with excitement, and evoked a desperate attack on the little annoyance with her teeth. She then gave it up as a bootless job. A bottle of hartshorn was next made the subject of investigation. She was not in the least disconcerted by the drug. In fact, she had a strong nose for such things. A man gave her his tobacco-box. Resting it on the floor between her two paws, which possessed uncommon flexibility, she turned it over and over, round and round, exercising alternately her nose, claws, and teeth upon it with great energy, but to no avail. It seemed that the smell of its contents infatuated her, as she showed no disposition to stop. The man opened the box for her. She was in rapture. In went the nose, also both front paws. Very soon that wonderfully mobile organ had separated every fibre, so that the mass seemed trebly increased. The same man let her have his dirty pipe, when her velvety nose was instantly squeezed into the rank nicotian bowl.

It would be wrong to infer that *Nasua's* prying propensity never got her into trouble. In the following instance, speaking metaphorically, she put her foot into it:—The old cat had just finished her nap, and was stretching herself, an operation which means that she stood with her four feet close together, the limbs elongated, the back rounded up like that of a camel, the head erect and drawn back, and the mouth yawning widely. Such a sight Nosie had never seen, hence it must be looked into. So in a trice, erect, and resting flatly on her hind-feet like a little bear, she put her arms round Tabbie's neck, and, reeking with nicotine, down went that inquisitive nose into the depths of the feline fauces. This unwarrantable intrusion was met by a reception more feeling than felicitous, judging from the haste with which *Nasua* withdrew to a corner of the room to ruminate on the untoward incident. Her method of relieving the injured member was itself original. She placed it between her paws, holding it tightly, then jerked it through them, giving a violent sneeze every time it came out. That sneezing was genuine, because it was involuntary. Both hartshorn and nicotine had failed to get up anything respectable in that line; but that catnip, pure and simple, did the business finely.

Quite pretty was the pattern of the animal's ears; they were so clean, trim, soft, and small. Though rather pert, they had an air about them that was really amiable, and such as the canine-fancier would pronounce elegant. She was not averse to a little fondling, and I well remember the first time she climbed upon my lap. Those

pretty ears suddenly quivered. The ticking of my watch had excited her. Down goes that ubiquitous, utilitarian organ into the watch-pocket. Failing with the nose alone, she makes a desperate effort with that organ and both fore-feet all at once. Still unable to evict that case of mystery, she thrusts her nose down by its side, and for several minutes, with simian quaintness, listens to the ticking of mortal time.

On the above occasion coati was allowed the liberty of going to sleep on my lap, while I gave myself up to the enjoyment of my book. Her nap finished, I did not notice when she left my lap. Soon a noise was heard like the tearing of paper. The wonderful little beast had abstracted my pocket-diary, and in violation of all propriety was making heavy extracts in a littér-ary way. Those keen incisors were scissoring away—a full leaf at a time! She had even filched a five-dollar note out of the pouch of the book, and, by way of change, had converted it into fractional currency.

In the same manner, though not to the same extent, the nose of the *Nasua*, like the same organ of the elephant, projects far beyond the mouth. At our first acquaintance with the animal we were anxious to see if it could drink out of a deep, narrow vessel. So a mug containing about a gill of milk was set before her. She instantly turned up the proboscis toward her forehead, and, in the easiest way imaginable, lapped the vessel dry. The organ was not even wet. The sight, though comical, was really pretty. It was the only time that I had ever seen the turning up of the nose at one's friends so deftly and gracefully done. And she could turn the same organ in a contrary way quite as easily. The first time she confronted a mirror, startled at beholding her own counterfeit presentment, instantly her countenance fell—very low indeed; for her nose bent downward, and actually curved under the chin. Of course the word chin is not here anatomically correct. Her proboscis now looked like that of a tapir in repose. This singular grimace, with its squeaky little grunts, presented a very funny manifestation of surprise.

Sometimes for an airing the animal was tied by a long tether to a flower-stand on the lawn. It should have been mentioned that she was literally omnivorous. She would catch a mouse and eat it all up. The heads of poultry given her in the kitchen would be eaten ravenously. The same is true of sweetmeats, which she occasionally got by stealth. She would drink everything, not even stopping at brandy. She had nearly all the appetencies of the domestic swine; and the end of her proboscis was essentially a swine's snout. I now beheld the use of this singularly-tipped organ. And an interesting sight it was to see that little thing plough up the greensward with the tip of her nose—and so easily. Here appeared the veritable swinish acuteness of scent for insects and worms, and the swinish facility for rooting in the ground. With surprising rapidity furrow after furrow was made, of about the width of a man's thumb. Whenever a worm or insect was discovered, as when drinking, the nose was curved up, so that the mouth could extract the object from the furrow.

The tail of *Nasua* is quite suggestive of the raccoon; but *Nasua's* tail is a much handsomer affair—longer, and with rings more numerous and of gayer colors. With admirable intelligence our pet put this beautiful appendage to a remarkable use. She was tethered by a string to a chair, and an egg was put on the floor at a tantalizing distance. She could just touch it with a paw, and that touch caused the coveted prize to roll out of reach. She turned her hind-feet toward it, pulling hard so as to stretch her neck; still, even with a hind-foot, she could not touch it. The logic of events was now, "get it if you can!" All this *Nasua* well understood, for she turned tail on the subject altogether—not, however, as did Reynard on the grapes, but strategically.

She gathered herself up and looked at the coveted object with speculative eyes. Then she swung herself round again, pulling hard on the tether by the neck. She then curved the tip of the tail so as to make a little hook. Now she grasps the base of the tail with one paw, as with a hand, thus stiffening and steadying the organ. She next slowly and cautiously rolled the egg, by the curved tip of the tail, through a section of a circle, until it was brought within reach of one of the front feet. The egg was now seized; sitting on her hind-feet, like a bear, she cracks it, extracts the contents, and neither spills a drop on the floor, nor so much as soils that wonderful nose; for among her many gifts is her soft and extensile tongue. This caudal expedient is sometimes found with the American show-monkey when a bit of gingerbread is put by the roguish boys at an inconvenient distance; but, as in such instance the tail is prehensile, is in fact the monkey's fifth hand, such feat is no great shakes after all, but is quite in keeping with what the organ is cut out for. It is at most but little more than that instinct which structural or functional capacity might evolve. But in *Nasua's* case it is animal contrivance pure and simple. There is, too, a latent fact which peeps out here; for this bending of the caudal tip looks to the faculty possessed by its cousin, the kinkajou, the extremity of whose tail has a prehensile or grasping faculty of high perfection.

She showed considerable attachment—her preference being the ladies. She would often, when tied up in the kitchen, sit for many minutes, her little black eyes looking wistfully at the door through which the mistress of the house had passed, and all this time crying pitifully. It was a plaintive cry in the minor key, and yet a little funny, for it greatly resembled the chirping of a cricket, though not quite so shrill, and the intervals between the notes were a little longer. This tiny cry required for every note a muscular exertion, extending far down the sides of the body, which led to the suggestion that "the plaint came from the depths of the heart."

The attachment of this interesting animal to her new home was intense. I frequently caused her to be taken to the commons and set at liberty among the trees. Considering that the coati is a thoroughly arboreal animal, one would suppose that this would awaken the dormant natural habits; but she would invariably hasten home by the shortest route possible; and if on her return she found the door closed would sit on the steps and cry.

A word is necessary as to the peculiar temerity of this animal. From two points it was liable to give way to extreme impulsiveness—the excitement of opposition or of inquisitiveness. If anything attacked her, whatever the object or the odds might be, she would face the assailant, and close in with her shrill little squeaks of rage, and in a wild sort of dash. If one slapped her, whatever might be her terror, she would rush upon and snap at the hand. The dog-like sagacity of running under the table or chair was not her way. Hers was the peccary instinct of rushing upon danger. No monkey could be a more importunate or impertinent teaser than was our coati; but Jocko shows sagacity with his jokes, for he always adroitly leaps aside of consequences. I have watched our pet tease the cat with imperturbable persistency, until Tabbie, unable to tolerate matters any longer, has struck her sharp claws into that soft proboscis, then moved away, leaving her persecutor dazed with astonishment. Then in a moment forgetting all she would turn her attention to the setter-dog, and, despite his growls and menacing teeth, would keep up a systematic worrying—catching at his tail, nipping at his legs, and even poking her nose into his ears. At length the poor brute, fairly goaded into rage, seized her like a rat, and, but for my prompt

interference, that would have been the last display of *Nasua*'s rashness. One morning she got into the dining-room as we were at breakfast. She took possession of madam's lap. Her first act was to poke her nose at the coffee-urn. This evoked a squeak of pain. Her next essay was on a cup of hot coffee, with a similar result. She now smelt the contents of the sugar-bowl. This discovery so excited that "sweet will" of hers that instant removal became imperative. Later in the day she tried to capture a wasp. She struck it down and held it a second under her foot. This was met by an appeal addressed solely to her understanding, of so pointed a nature as made her chatter with distress. Disabled in one wing, the insect could not fly away. Although still smarting from the wounded foot, the moral of the lesson is only half learned. Coati cannot give "little yellow-jacket" up. So she tries the wasp again — this time with her nose. Alas, that sting! Miss *Nasua* now finds that other little folks besides



FIG. 175. — *Cercoleptes caudivolvulus*, kinkajou, potto.

herself can utilize their tails; for in proof of this she receives not merely a duplicated but an intensified experience, such as exacts a staccato outgush of agony of truly simian expression.

In *Nasua narica*, the Mexican Coati, the pelage is full, long, and soft, and the hairs on the dorsal surface tipped with rufous, fulvous, or whitish. This species doubtless is similar in habit to the Brazilian. Its range as known at present seems to be from the Isthmus of Panama northward throughout Central America and the warmer parts of Mexico. It may be said of both species that each one seems to be the sole representative of the genus in its own range, for the two species have not yet been obtained in the same area.

The third family of these coon-bears is the CERCOLEPTIDÆ, with its one genus and one species, *Cercoleptes caudivolvulus*. This is the Kinkajou, or Potto, of South America. From nose to base of tail the animal is about eighteen inches long, and the

tail is about twelve inches. The body is about as large as a good-sized cat. The pelage is light or yellowish color. The snout is short and a little tip-tilted, enough to impart an air of inquisitiveness. Like its neighbors, the South American monkeys, it has a true prehensile tail, which it can coil with two or three turns round the branch of a tree. This faculty, with its singular quadrumanous dexterity, for it can put food to its mouth with either its fore or its hind feet, caused it formerly to pass among naturalists as a lemur, one of the lowest of the monkeys. As such it had a systematic name, *Lemur flavus*, the Yellow Lemur. Its dental system is that of an herbivore, and its rightful place is among the Arctoidea. Its hands have no opposable thumbs, and its fingers are webbed for nearly their whole length, yet it can hold food in one hand and break it up and feed itself with the other hand. While the heels of the hind-feet are well raised, it walks with the soles of the fore-feet on the ground. The tongue is long, slim, very extensile and flexible, and it can insert it into small and deep places in search of insects, or the honey nests of the wild bees, in whose sweets it delights, and of which it is very destructive. It is arboreal in its habits; a facile climber, descending head downward, like the coati. It does not like the light, but seems to suffer from it, hence it is only active at night. Though known to be fierce and courageous in the wild state, when tamed it makes an intelligent and even affectionate pet. Its round head and flat cat-like face give the pretty little animal a knowing and attractive look. With its caudal apprehension and all-round handedness it is admirably endowed for its arboreal life.

The last family of these procyon arctoids is the AELURIDÆ. It contains the Wah, or Panda, *Aelurus fulgens*, the most elegant animal in the entire group. It is scarcely larger than the domestic cat, and excels in the brilliancy of its pelage, which, however, is of no great commercial value, although the fur is thick and soft. It is curious that in its very splendor, this little beast disregards, so to speak, nature's pattern of the coloration of the pelts of animals. As a rule, the darker colors are laid on above, and the lighter ones below. The fur on panda's back is a warm, rich cinnamon-red, a tawny yellow or fawn color behind, and a deep black beneath. Over all this is the rich gloss of a satiny lustre. There is some white on the head and face, and the long, ringed tail is like a lady's boa, of alternate bands of chestnut red and yellow. Thus arrayed it is not to be wondered at that Cuvier should pronounce this little animal the most beautiful of quadrupeds. The soles of its feet are covered with wool for the long winters of its home in those vast elevations. It delights in the sides of streams and mountain torrents. It has large claws, which are half retractile, and its walk is plantigrade. In fact it is very bear-like, both in structure and habit. A panda in the London zoological gardens is described as sucking the water like a bear, not lapping like a dog or a cat. When enraged at its keeper it rushes towards him on its hind legs, like Bruin himself, and in like manner strikes with its claws protruded. It vents its anger in a spitting noise, and at other times utters a weak, squeaking call-note. On level ground it runs like the weasels, in a jumping gallop, keeping its back arched."

The panda was made known to science by General Hardwicke, who obtained it in the eastern Himalayas. It was long the only species known of its genus, and was held to be a type peculiar to the higher Himalayas; hence the interest in the animal was considerable. Now, however, both these facts are modified. The Abbé David has discovered the panda in the high mountains of eastern Thibet. He also gave to the world at the same time, in 1874, a new member of its family, which Alphonse Milne-

Edwards has named *Ailuropus melanoleucus*. The interesting features are the great size, and the pure, snowy whiteness of the new species, suggesting even the Arctic bear. In external appearance it resembles a large white bear, with a black band across the back. Further, says "Nature," "These two genera constitute a special family of carnivores, representing in the Palæarctic region the Procyonidae of the New World. *Ailuropus* is a large, bear-like animal, clad in snow-white fur. It inhabits the highest forests, and is called by the Chinese hunters 'Pae-Shiung,' or white-bear. Its food is said to be of a vegetable character."

This concludes the first section of our group Arctoidea, namely, the Arctoidea procyoniformia; and this discovery by Père David of the great white bear-like Ailuropus, joins our coon-arctoids so naturally to the true bears as to make the link almost imperceptible.



FIG. 176. — *Ailuropus melanoleucus*, panda, wah.

As we have now reached the Arctoidea typica, that is, the URSIDÆ, or true bears, we can better discuss here the most marked peculiarities of the type—in a word, the most bear-like characters. The true bear is entirely plantigrade. When walking, the soles of all the feet are put flat on the ground. The step seems to a degree clumsy, awkward, and, beyond necessity, heavy. How different is this from the movements of the digitigrade cat, who steps so daintily, gracefully, and lightly, and, if need be, so softly and silently, on the very tips of its toes. Neither is the bear's countenance at all prepossessing, or the cut or quality of its coat attractive. But "the cat has a clean-cut, rounded face, with beautifully chiselled nostrils, and thin lips. The bear has a long snout, almost like that of a pig. The fur of the cat is usually short, and brilliantly colored; that of the bear is long, shaggy, coarse, and sombre." The cats are almost exclusively flesh-eaters. As a rule, the bears are vegetarians, though all will eat insects, and the most of them seem to be fond of ants, as if they had an appetency for formic acid; and generally the bears can easily acquire a taste for flesh. It is found,

however, in menagerie practice, that if restricted to vegetable food, they will be content and will thrive.

For his vegetable diet we find a corresponding adaptation of the bear's teeth, for though it has the same dental set, as to number, as the dog, yet they are greatly modified in form. The incisors and canines do not differ materially from those of the dog; but the change is very marked in the last premolar and all the molars, which, instead of the sharp, cutting edges, and their lapping position like shear-blades, have their crowns flattened, and set with raised tubercles. Even the remarkable flesh-teeth, or sectorials, are in like manner modified. Indeed, while the false molars are not large, the true molars are of considerable size, and have become actual grinders, instead of cutters. Hence the scissor-blade, or up and down motion, the only movement of which the jaws of cats and dogs are capable, is now impossible, and in fact useless to the bear for masticating purposes. As a vegetarian, it is necessary for him to be able to chew. Hence the hinge of the lower jaw must be differently shaped, and the organ itself so set or hung, as to command a movement from side to side, instead of only up and down, which is a necessity for the other carnivores. In a word, the bear's molars are formed and set with a capacity for actual grinding or chewing, a mode of mastication which is necessary to the herbivore, of whose nature the bear so largely partakes, and whose food needs to be passed to the stomach in a softened or pulpy condition, that is, crushed, ground, and mixed with saliva. All that the actual carnivore is concerned about is to cut, tear, or separate its food into pieces sufficiently small to pass the gullet. With it digestion begins in the stomach; with the bear it begins in the mouth. The alimentary system and the dental formula have a close relation. It should be mentioned that among the more carnivorous species of the Ursidæ the false molars are soon lost.

It must be admitted, however, that while the bears are well adapted to a vegetarian diet, they can acquire an appetite for flesh, and in general, in the wild state, a mixed diet seems almost the normal rule. The farmer knows by sad experience that Bruin does like pig and lamb. A strange anomaly meets us in the case of the Polar bear. With the same teeth and digestive apparatus of the most vegetarian of its family, it is a carnivore out and out. It may be added that even the Polar bear in confinement learns to like the crackers and confections thrown to it by the children; nor does it quite ignore vegetables in the Arctic summer.

Geographically, the Ursidæ are almost cosmopolitan. Though not as a class favoring hot climates, they have a very wide range. They are in the Andes of Chili, and in high Arctic regions, also in Europe and Asia, and the great island of Borneo, but not at all in Australia, and it would seem only traditionally in Africa. The classical writers, Herodotus, Virgil, Juvenal, and Martial, mention Libyan bears, and according to Pliny, before the Christian era, Ethiopian hunters exhibited Numidian bears in the Roman circus. Indeed the Romans used many bears in the brutal sports of the arena. To naturalists, however, it is an obscure question; so far as acceptable proof exists, *Ursus* is unknown in Africa. In the mountains of Abyssinia the natives tell of an animal which they call Karvai. Ehrenberg and Forskål say they saw and hunted it, but they failed to capture it, though they describe it as a black plantigrade.

The following is Jordan's concise diagnosis of Ursidæ: Plantigrade Carnivora having the body thick and clumsy; tail rudimentary. Teeth forty-two; molars broad and tuberculated, according with the omnivorous diet. Species few and widely dis-

tributed, — in North America, although many have been described, there are probably but three species of bears, the polar, the grizzly, and the black.

It would be in place, and certainly not without interest, to preface the typical Ursidæ with some account of the ancestral family, so long extinct, the Hyænaretidæ. But, at the best, to the general reader the story of the extinct forms must be somewhat obscure, and we think that the little we may have to say will be much better understood at the close of the account of the living Arctoidea.

We must first take Meyer's genus, *Melursus*. *Melursus labiatus* is indigenous to India and Ceylon, ranging from Cape Comorin to the river Ganges. Hence a fitting popular name is the Jungle Bear. It is too, often known as the Sloth Bear, or large-lipped bear. Among the true bears it is perhaps the most uncouth of the entire family. In fact, it took its place among them as a very doubtful character. *Melursus* at an early age loses the front teeth or incisors, and the cavities so made soon close up, as if no teeth had ever been there. As this smooth and toothless condition of the front of the mouth is true even of very young individuals, naturalists were deceived, and jumping to a conclusion, regarded the animal as an Indian sloth. One even wrote it down as the "Anonymous Animal." But it was not long left nameless, for the systematists, in learned gravity soon dubbed it *Bradypus pentadactylus*, and *Bradypus ursinus*, the names meaning respectively the five-fingered sloth, and the ursine or bear-sloth.

The generic name of this animal, *Melursus*, meaning honey-bear, has reference to its love for that sweet, though we think it is not at all peculiar in this respect among the bears. The specific name, *labiatus*, meaning lipped, is well given, for emphatically it is a much-lipped creature. In fact, as a show animal its fortune consists in its labial opulence. No other of the whole ursine tribe can produce such facial grimaces as can this our jungle bear. Not only are its lips long and flexible but there is a singular mobility in the snout. Sitting on its hind-feet, with this curious labial and nasal dexterity, it will attract attention. The nose, as if gifted with a caudal capacity, perhaps to make amends for the absence of that member from its proper place, will move from side to side, a genuine nasal wag; and the lips will go up and down — then shoot out to an extraordinary length — then will come a labial clap, or smack, if an actual slap of the lips may be so called. This series of contortions of the countenance is irresistibly comical, and the entire performance constitutes a grotesque beseechment which is sure to win the cake from the laughing spectators.

In India this animal is called Aswail. It is the juggler-bear of that country, and is there what the brown bear is to the strolling mountebanks of Europe. There is this difference, however: the street showman of Europe loses nothing by having his beast handsome and in good condition; whereas the Indian juggler makes a telling point in the positive ugliness of his animal. It is mild and submissive when tamed, and to some degree even affectionate, and it has sufficient intelligence to be taught a few interesting tricks.

The fur of aswail is black, except a little dirty whitish on the nose and tips of the feet. It has a characteristic V-shaped mark of a yellowish white on the breast. Its black coat is very shaggy, with a not prepossessing, unkempt aspect. It is thick and very long, especially on the back, neck, and head, where it overhangs the eyes almost like beetling brush. And not without reason is this uncouth coat, for the mother bear puts her shaggy robe to a true maternal use by carrying her little ones upon her back when too feeble to keep pace with her, the ample fur affording a good hold for the cubs.



Melursus labiatus, sloth bear, large-lipped bear.

The appetency of the jungle bear is not naturally towards flesh. Only hunger can make that acceptable. It lives on vegetables, fruits, wild honey, and insects. It has a great love for the large Indian ants, and a singular aptitude for obtaining them—the ransacked ant-hills often giving the trail to the hunters of the bear. It seems that our bear is an accomplished sucker and blower. Says Tickell, “It is by this enabled to procure its common food of white ants and larvæ with ease. On arriving at an ant-hill, the bear scrapes away with the fore-feet until he reaches the large combs at the bottom of the galleries. He then, with violent puffs, dissipates the dust and crumbled particles of the nest, and sucks out the inhabitants of the comb by such forcible inhalations as to be heard at two hundred yards’ distance or more. Large larvæ are in this way sucked out from great depths under the soil.” It must not be understood that the animal does all this with perfect impunity. When attacking the nests of the wild bees and the homes of the white ants, the nose, lips, eyelids, and toes “get it,” for the plucky insects, made furious, go for the vulnerable parts of the invader; on which occasion it is supposable that aswail’s blinking and nasal waggers serve a good purpose.

As handsome is that handsome does, it is hardly the fair thing to speak of this animal as the sloth bear. The native hunter does not so regard it, but entertains a prudent fear of its prowess, and admiration of its good qualities. Tennent describes the pursuit of a terrified native by a she aswail with her two cubs. “This native had on him an unfailing charm against bears. He had unexpectedly fallen on the beast, and despite the charm he fled with all the speed that terror could excite. The bear kept gaining on him, she running on all four feet, when a ball from a hunter broke her shoulder. But this did not stop the enraged animal, for she still pursued the man, but now on her two hind legs. A second discharge of the gun caused the courageous creature to turn and retreat, her cubs keeping up as well as they could. The poor fellow when rescued was unable to speak, and for weeks his intellect seemed confused.” And it is no wonder that a man should have been badly frightened under such circumstances. The jungle bear has a fearful way of attacking the face and eyes, tearing with its claws.

This animal might be called the cave-bear of India, as it is said to live in the mountain caves or hollows in the rocks. Attaining a length of from four to five feet, and strong, and ferocious, it becomes a not mean antagonist to encounter. Though fierce in its wild state, it is very mild in captivity, but carries then an air of melancholy. It is said to have very tender feet, which, if compelled to travel on the hot ground, get badly burned, so as sometimes to disable it, an advantage which the hunters know how to take. Thus the animal courts the shade.

The locomotion of the jungle bear is a little curious. While standing still the feet are pretty wide apart, but when walking or running there is an inward swinging of the limbs so that the forward feet cross each other. With its uncouth, shaggy coat, its swaying, lumbering gait, its grotesque mobility of muzzle and lips, and owing to its deciduous front teeth, the edentate aspect when the mouth is opened, its depressed head, hilly back, short limbs—in fact, in the entire make-up of the aswail, it is singularly *outré* even for a bear.

The genus *Helarctos*, meaning Sun Bear, strictly embraces but one species, *Helarctos malayanus*. The Malayan Bear, or Bruang, is confined to the Indo-Malayan sub-region, that is to the Malayan peninsula and the neighboring islands, Borneo, Sumatra, and Java. It is much smaller than the Himalayan bear, not exceed-

ing four feet and a half in length. The fur is black, becoming brownish on the nose, and for a bear is fine, short, close, and glossy. On the chest is a crescentic white mark, or in the Bornean variety of the species a heart-shaped, orange-colored patch. The claws are of great length — which remark, in a greater degree, is true of the tongue. The great flexibility and power of extension of this organ give it great facility in probing wild-bees' nests, and the retreats of insects.

Says Dr. Jerdan, in "Mammals of India":—"The sun bear is generally found at a considerable elevation, nine to twelve thousand feet, and often close to snow; but in winter it descends to five thousand, and even lower sometimes. It lives chiefly on fruits and roots, apricots, walnuts, apples, currants, etc.; also on several grains, barley, Indian corn, buckwheat, etc.; and in winter chiefly on various acorns, climbing the oak trees and breaking down the branches. They are very fond of honey. Now and then they will kill sheep, goats, etc., thus occasionally eating flesh. This bear has bad eyesight, but great power of smell, and if approached from windward is sure to take alarm. A wounded bear will sometimes show fight, but in general it tries to escape. It is said sometimes to roll itself into the form of a ball, and then roll down steep hills if frightened or wounded. If met suddenly where there is no means of escape, it will attack man at once; and, curious to say, it always makes for the face, sometimes taking off most of the hairy scalp, and frightfully disfiguring the unfortunate sufferer. There are few villages in the interior where one or more individuals thus mutilated are not to be met with."

The Bruang has a smallish head and a short neck, which is very strong, enabling it to tear up the great plantains. It is also destructive to the cocoanut groves. As this nut and the banana constitute so largely the sustenance of the natives, the animal is regarded as a pest. When tamed it shows so much affection and has so many droll ways as to make it an amusing and prized pet. Even when a caged captive it is in constant motion, and this not the painfully monotonous, automatic movement of the white bear, so indicative of a sense of deprived freedom, or the mild melancholy of the captive honey bear, but it is an activity which seems the irrepressible outcome of a brimfulness of life. Although in many of its aspects this restlessness is very ludicrous, it is really amiable animal gush. At any rate it makes the bruang a star card in the menagerie. It will walk upon its hind-legs as if upon a constitutional that meant business, when most unexpectedly the promenade is arrested, and, still standing on its hind-legs, the flexible body goes into a series of indescribable contortions. Putting the head on the floor, and tilting the tailless end in air, it goes over, and comes down in a heap, thus achieving a somersault to a degree clumsy and ludicrous. Then comes a pause, as if for the moment it had exhausted its talent in the line of ursine gymnasts. Now, unconsciously, as some humans do, it turns buffoon. Mounted on its hind-legs, swaying its pliant body as if it were a billow of sarcode, gesticulating with its forelimbs, protruding its long tongue to an inordinate extent, then fetching it in with a jerk and a clucking sound—this clownish rôle is a source of merriment to the spectators. Perhaps this good temper it is that makes the bruang more entertaining than the honey bear, albeit the inimitable facial pranks of the latter.

If "my Lord Mayor's fool" was accounted a wise man by the epicures because "he knew what was good," then was Sir Stamford Raffles' tame bruang well endowed with worldly wisdom. Though a patron of learning, the founder and first president of the Zoological society, and a famous author, yet Sir Stamford is more widely known by his graphic story of his tame Malayan bear, which, notwithstanding its being often

cited, it would be culpable in us to pass by. At any rate a brief extract must be given. Says the knight, "He was brought up in the nursery with the children; and, when admitted to my table, as was frequently the case, gave a proof of his taste by refusing to eat any fruit but mangosteens, or to drink any wine but champagne. The only time I ever knew him to be out of humor was on an occasion when no champagne was forthcoming. He was naturally of an affectionate disposition, and it was never found necessary to chain or to chastise him. It was usual for this bear, the cat, the dog, and a small blue mountain bird, or lory, of New Holland, to mess together, and eat out of the same dish. His favorite playfellow was the dog, whose teasing and worrying were always borne and returned with the utmost good humor and playfulness. As he grew up he became a very powerful animal, and in his rambles in the garden he would lay hold of the largest plantains, the stems of which he could scarcely embrace, and tear them up by the roots."

The Bornean sun bear has been described as a distinct species, under the name *Helarctos euryspilus*. Though it shows some small variation from the Malayan sun bear, it is not enough to claim the dignity of a species, and is simply a variety. It is questionable if the average difference of habit, even, amounts to a characterization. Both have a singular trick of playing with their food, like the raccoon, though in a much less offensive way. The bruang will take its biscuit from the keeper, and, lying on its back, will turn it over and over with front paws, occasionally holding it with all four paws brought together, and it is said of the Bornean variety that it will, standing on the hind-legs while feeding, put the food it cannot hold in its paws carefully on the paws of the peds, as if to keep it off the floor on some consideration of cleanliness.

Our next form is *Tremarctos ornatus*, sometimes found written as *Ursus ornatus*, and again *Helarctos ornatus*. The meaning intended by its specific name is the ornamented bear, the ornamentation, like that of the painted brave, consisting in a display of countenance combining the grave and the comical. It is popularly called the Spectacled Bear, because of a light-colored ring around each eye, through which, as if they were goggles, a pair of mild optics gaze with a quasi-owlish wisdom. Geographically it has a singularly isolated home, its range being limited to the high mountain forests of Chili and Peru. The animal is about three and a half feet long, its pelage is black, and there is but one species in the genus. It really seems to have had a fossil ancestor in the post-pliocene period of South America; for in the caves of central Brazil, among millions of mammalian bones, Dr. Lund discovered the osseous relics of an extinct bear, to which was given the name *Arctotherium*, literally, the bear-beast, which Wallace says "is a genus closely resembling, if not identical with, that containing the spectacled bear of Chili." This bear of the Cordilleras has been compared with the Malayan bear, and it has been even hinted that it might be only a variety of the same species. But when it is considered that the two species are found in such widely different faunal provinces, the supposition is itself not less than extraordinary. The truth seems to be, that this bear is worthy to form a distinct group. It is so much of a unique among the Ursidæ that the first systematists have deemed it deserving generic distinction, hence the reason for taking it out of *Ursus* and creating for it the genus *Tremarctos*. With few, if any, engaging traits in captivity, it is, however, spoken of as most comical and grotesque.

Ursus arctos, the Brown Bear, is widely spread, being found in "many parts of Europe, Norway, Russia, central Europe, Spain, in Siberia, Kamtschatka, and Japan, and in a part of the arctic regions of North America." In former times it was found

in Britain, whence it was imported by the Romans, under the name of the Caledonian bear, for the sports of the amphitheatre. The brown bear of arctic North America, called the Barren-ground Bear by Sir John Richardson, "who found it on several occasions in the barren-grounds of the arctic zone," has been named *Ursus richardsonii*, although its right to be held as a distinct species is far from certain, it is so much like the brown bear.



FIG. 177. — *Ursus arctos*, brown bear.

Of the common brown bear, says one writer, it "is an awkward-looking brute, with sprawling gait, heavy body, and no tail to speak of. It is about six feet long, and about three or three and a half feet high at the shoulder. Its fur is longish, rather woolly, and of a dark brown hue. It lives a solitary life, and, like many of its kind, has the curious habit of hibernating." As to the "awkward-looking," and the "sprawling gait," we beg leave to differ. The brown bear has a grace of its own, even if it be an ursine bearing. A Switzer last summer brought his brown bear to the writer's house, and put the animal through its paces on the greensward. The man

sang an air rather plaintive, and in a low voice, at the same time keeping up a soft dance movement. The bear, on its hind-legs, imitated him, and despite the natural ungainliness, the rhythm and grace of movement caused us surprise and pleasure to witness. The erect carriage of the beast was also remarkable. As it moved on its hind-feet the back made a perfectly straight perpendicular line. The animal was told to shake hands with me. It went through the motions, but the claws were so formidable that a repetition of the politeness was declined, with thanks. At our request the man ordered it to climb a maple tree, at which the brute growled its reluctance, nor did it obey until urged by the threatening of the master's club. The boll of the tree was nearly eighteen inches through. The animal made good use of its claws as grapnels, relying upon that method more than on the hugging climb which is reputed of the bears, and it was observed, to our surprise, that when it had descended it puffed like one whose breath is well-nigh spent. The truth told, the brute had performed an unwilling task, with a real outlay of physical exertion, leaving the impression on our mind that bear-climbing is done by main strength.

A curious statement is made in respect to the brown bears of Scandinavia, that they persistently, at night, scratch the soil away from the bottom of the telegraph poles. That undefinable humming of the wires at night deceives the animals into the belief that the sound is the buzzing of bees, hence the deluded brutes scratch to find the honey.

Being the best known of any member of the ursine group, the brown bear has any amount of stories put to its credit. Some show large sagacity, others extraordinary affection. A judicious selection would be entertaining, had we room to spare for them.

"The she-bear is said to be even more fierce and terrible than the male, especially after she has cubbed, and her furious passions are never more fiercely exhibited than when she is deprived of her young. When she returns to her den, and misses the objects of her love and care, she becomes almost frantic with rage. Disregarding every consideration of danger to herself, she attacks with great ferocity every animal that comes in her way, and in the bitterness of her heart will dare to attack even a band of armed men. The Russians of Kamtschatka never venture to fire on a young bear when the mother is near; for if the cub drop she becomes enraged to a degree little short of madness, and if she get sight of the enemy will only quit her revenge with her life. A more desperate attempt can scarcely be performed than to carry off her young in her absence. Her scent enables her to track the plunderer, and unless he has reached some place of safety before the infuriated animal overtakes him, his only safety is in dropping one of the cubs, and continuing his flight; for the mother, attentive to its safety, carries it home to her den before she renews the pursuit."

In some way it has come about that among the natives of both the Old World and the New, Bruin has secured for himself an almost superstitious respect. The Scandinavian regards him as endowed with superhuman capacities, and accredits him with "the strength of ten men, and the wisdom of twelve." On no account must he be spoken of disrespectfully; nor is it wise even to allude to him with familiarity as "the bear." So there has grown up a euphemistic formality; and in a quasi-reverence the beast is referred to as "the old man with the fur cloak," "the dog of God," "the Disturber," and similar dignified epithets.

In the Himalayas is a fine species known as the Indian White Bear, or the Isabel-line, *Ursus isabellinus*. The pelage is nearly white, though varying with age and

the season until it becomes almost a fawn color. Its claws are comparatively small. It is by preference a vegetarian. It is held by some to be a variety of the Syrian bear.

The Syrian Bear, the bear of the Bible, *Ursus syriacus*, though not so abundant, still roams in the mountains of Palestine. This beast can boast the oldest historical record of any of its tribe. It occurs so often in the Hebrew Scriptures, in historic mention, and in poetical figure and allusion, that a fair account of it could be made out from this source. It was the prowess of the youthful shepherd in killing a bear that had caught a lamb in his father's flock that gave the promise of his future career; but this statement shows that the vegetarian bear of Palestine, like our own black bear, became a carnivore under stress of want of food. In poetical allusions we find the roaming habits indicated, and the roaring is spoken of, and its "lying in wait," a trait so strongly feline that we hesitate at its interpretation. The maternal fury of this bear appears in the fine simile of the pastoral poet Hosea, "I will meet them as a bear bereaved of her whelps."

The bear of Palestine has a not distant alliance to the brown bear, but it is less sanguinary. "Its stature is lower, and in proportion to bulk longer, the head and tail more prolonged, and the color a dull buff or light bay, often clouded with darker brown. On the back is a ridge of long, semi-erect hairs, running from the neck to the tail. It is yet found in the elevated parts of Lebanon. In the time of the first Crusades these beasts were still numerous, and of considerable ferocity; for during the siege of Antioch, Geoffrey of Bouillon, according to Matthew Paris, slew one in defence of a poor woodcutter, and was himself dangerously wounded in the encounter."

To our young readers especially, considerable interest must be entertained for this species as the avengers of that stinging, Oriental insult of the young idolaters, who hootingly ordered the prophet to "go up, thou bald-head." They were two she-bears, and the conjecture has been made that the beasts had lost their cubs, in which case numbers would not have deterred the infuriated animals from a slaughterous attack.

The following, for its moral and its humor, cannot be withheld. It was written in August, 1874:—"Several hundred persons attended the funeral of a tame bear near Boston a few days ago. An invitation to be present was sent to the Autocrat of the Breakfast Table, who responded as follows: 'Dear sir,—Many thanks for your polite invitation to attend the obsequies of the lamented plantigrade. I am sorry that it will not be in my power to be present upon the melancholy occasion. I have a great respect for bears since those two female ones taught the children of Bethel and of Belial that they must not be rude to elderly persons. I think a loose bear or two might be of service in our community, and I regret much the loss of an animal who might have done so much as a moral teacher for the young of this city and its suburbs. I am, dear sir, yours very truly, O. W. Holmes.'"

The Black Bear (*Ursus americanus*) belongs to North America. Except a little on each extreme, its home is the temperate zone. "It weighs from two hundred to four hundred pounds, is of a uniform black or deep color, and the hair is comparatively soft and glossy." It does not deserve to be called ferocious, as under ordinary circumstances it desires to get away from man. Said a bear hunter to me, "Once when without my gun, I suddenly confronted a big black bear in the Adirondacks. He stood and looked at me. You must not turn from them at such a time; that

would invite attack; but stand your ground, giving the beast a chance to get away. I stood still, but hallooed at him. The bear turned, walking slowly, and once in a while looking behind him. Then he went off at a run." Its natural food is berries, acorns, and, most generally, succulent plants, even skunk-cabbage, and it eats freely the Indian turnip, *Arisæma triphyllum*, which, though farinaceous, has a juice so acrid that it burns worse than cap-sicum. Professor Tenney examined the stomach of a black bear killed in June, and found it filled with vegetable matter, chiefly the stalks and corms of the Indian turnip, and not a particle of animal matter. The beast was very fat. This bear seems to seek the swamps and ponds in the warmer part of the year, mixing in his diet mollusks, reptiles, salamanders, insects, and even fish. In the fall it seeks the higher land for the mast, acorns, nuts, and such. They will go a great distance for an apple orchard, avoiding the sour fruit; hence under a sweet apple tree is a good place to set a trap. No animal so well as the bear knows the seasons, and the topography of the country. He knows the clearings where and when the wild berries grow. A knowledge of Bruin's habits in this respect is of service to the hunter; for though when after his rations the bear is a great traveller, he travels on system.



FIG. 178. — *Ursus americanus*, black bear.

Bears, as a rule, hibernate, and among our American bears the black is the type in which to study the phenomena of hibernation. For reasons that will appear, the female hibernates longer and more profoundly than the male. They go into their long sleep very fat, and seemingly come out of it in spring as fat as they went into it in the late fall. The beast is reputed to have a trick of sucking the soles of its feet. It comes, undoubtedly, of the fact that the plantigradal habit begets, on the naked soles, a thick, callous skin, which cracks and peels, the animal aiding the process by licking and biting. The new skin is thin and tender, and the licking is simply the applying of a natural unction. It takes the poor creature some time in spring to get his feet in travelling condition, a fact which the hunter turns to profit.

During the winter sleep a tappen is formed, that is, a plug which closes the alimentary vent. According to the completeness of this depends, as the hunters believe, the completeness of the winter sleep. It is simply due to the desiccation of the last fœcal mass with the mucus of the alimentary canal; really an effect of costiveness. "As soon as they begin to eat in the spring, the plug comes away from them, black, shining, and hard, resembling gum."

In choosing their winter retreats the males, especially when full grown, do not like to climb. They will seek holes or caves, either in the rocks or under the roots of trees, into which, the hunters say, they will gather moss, leaves, and evergreen branches. With a necessity in the future which does not befall the male, the females and the young bears prefer the hollows of trees. The young seek to get out of harm's way, but the coming mother needs quietness for the period of gestation, of which some three or four months are already gone; the pairing took place in summer, and gestation running through some seven months, she becomes a mother not later than early in February. From two to even five cubs may be born, though the latter is an exceptional number. Here, then, occurs this remarkable fact, that for some time until the winter breaks, the mother suckles her cubs without herself taking food. Her own fat is absorbed, and elaborated into a lacteal supply for the little ones, while the dam is in a semi-slumber. When they make their appearance in spring the cubs are about the size of large kittens, and have a whimpering cry like a little child.

With wild animals generally their food habits constitute largely their lives; and what of ingenuity the animal may possess is thus given to getting on in the world. Bears like the larvæ of wasps' nests. Such as nest in the ground they will scratch up, digging with much rapidity, but often having to stop from the stings of the enraged insects. They will snarl, and roll on the ground, and go at it again. Though the punishment is severe, Bruin keeps at it until he has secured his hard-earned prize. The black bear is skilful in finding the resorts of the honey-bee in trees. It will climb such a tree, and, if necessary, enlarge the entrance to the treasure with its teeth. A gentleman narrated a sight actually witnessed in New Hampshire. He saw a bear up a tree, and all around him the air was gray and alive with bees. Bruin had effected an entrance to their stores, and was helping himself. He had both legs and one arm round the tree, and with the other hand was dipping out the dripping comb, and stuffing it into his mouth. But he seemed covered with bees, which in their way were taking vengeance, on his ears, over his eyes, on his face and nose, and occasionally a louder but mumbling note of distress, and a momentary thrusting out of the tongue, told plainly that he was 'getting it' in the mouth, thus, despite his fortitude compelling Bruin to give tongue to his tormentor. But Bruin kept at the feast until he was nearly stuffed with the sweets. He was utterly unconscious of the hunter's presence, who now fired, and the gorged animal fell mortally wounded.

There is nothing eatable of a vegetable character that comes amiss to the black bear. A farmer in the White Mountains found to his sorrow that his oat-field had been visited in the night by a bear, which, like his race, destroyed more than he ate. The farmer knew well that this visit meant much more mischief unless stopped; so in the evening he set the ugly bear-trap in the animal's trail. Next morning he found that the trap was moved a short distance and sprung, and that the oats had been visited again. So he replaced the trap, and reset it. The following morning he found it again removed to the same place, and sprung. This game was repeated next night. It now occurred to the farmer that the cunning beast must have pushed his paw under instead of putting it over the bait, in that way springing the trap. He set it for the fourth time, but now turned the trap upside down. The surmise was correct. Bruin again pushed his paw under; that sprung the trap, but the steel jaws snapped downward, and the wily beast was a captive. It may be asked, Why did not the bear turn aside from the trap? Probably the correct answer is that while animal devices are often above experience or instinct, they very seldom go contrary to them. The

trap was set in the trail; the farmer knew that bears do not like, when prowling, to go off a chosen track, hence the animal's mishap; albeit its intelligence, it fell a victim to uniformity. This pertinacity of habit often betrays the black bear to the hunter. Says Henry Clapp, "Bears bite fir and spruce trees, and tear down the bark, and when one has bitten a tree others are apt to do the same, and thus the ranges or lines of travel become spotted, as it were. They follow their ranges, year after year."

A similar statement to the above is made by Benjamin Burke, a bear-hunter in Texas. "In some localities, particularly on a high bluff near a stream, a pine-tree is occasionally seen from which the bark at a certain height is plainly torn off by the teeth of some animal. It is said to be done by the bear in this manner: he rises on his hind feet, with his back to the tree, and turning his head to one side and to the other, rips off the bark with his tusks. The size of the animal is known approximately by the height of the marks he leaves. The same tree is visited year after year by bears of various sizes; none very small, however. I would say, trusting to memory, that the average height may be about four feet. I have seen several such trees. I never saw any other than a pine-tree thus marked."

A singular instance of cunning and duplicity connected with the strong appetite for sweets, was shown in a captive bear at Twin Mountain House, N. H. It had lost one paw in a trap. It was passionately fond of sugar, and the guests often gave it a supply. So long as one fed it a lump at a time, keeping still some in reserve, the animal would behave properly, and take the proffered lump gently from the hand that tendered it. The store might be exhausted save just one lump, and up to that point a child could safely feed it. But woe to the one who from ignorance extended the hand with the last lump of sugar. The vicious beast would secure the sweet, but surely mutilate the hand of the giver.

Our black bear, says Henry Clapp, "varies exceedingly in color, size, and disposition. I had at one time two tamed ones, which I caught with their mother when they were cubs. The larger of the two tamed ones was of a mild disposition, and would learn more tricks than the other. Both were females. They had a disposition to pry into everything. One of them got into the pantry once, and upset the flour barrel, and went to eating the flour. When she got her mouth so full as to be clogged, she would clear it out with her paws. She threw the sieve and bread-board out into the kitchen very handily. Another time she got in and took the eggs. They like milk and honey and molasses. One would drink milk from a dipper, holding it in her fore-paws. One, if she got loose, would find every hen's nest in the barn, and eat the eggs.

"They strike their enemy, and try to throw him down, and then bite and tear him. I never saw them hug, and don't believe they do it. They can climb small trees as well as large ones. I have seen where one climbed a cherry-tree not more than three inches in diameter. I kept one of my tame ones till she was six years old, and have time and again seen her climb a pole four inches through. She climbed with the ends of all her claws touching the pole; would climb deliberately oftentimes a day for gingerbread, apples, etc. She would walk hand over hand along a horizontal pole with her body hanging under it."

Of the hibernation of his tame bears Mr. Clapp says: "In the barn they covered themselves all over with straw, excepting their ears. Their paws were brought forward around the nose, which was dropped forward and downward. When I spoke to them during the winter they would look up very bright, would run out their

tongues, gape, and drop their heads forward and down between their paws again. I could see the motion of their breathing, and on a cold day could see their breath condensing."

In his "Exploration of the Red River of Louisiana," Captain Marcy attributes high sagacity to the black bear. "Before making his bed to lie down, the animal invariably goes several hundred yards with the wind, at a distance from his track. Should an enemy now come upon his track, he must approach him with the wind, and with the bear's keen sense of smell he is almost certain to be made aware of his presence, and has time to escape before he is himself seen. When pursued the bear sometimes takes refuge in caves in the earth or rocks, where the hunter often endeavors, by making a smoke at the entrance, to force him out; but it not unfrequently happens that instead of coming out when the smoke becomes too oppressive, he deliberately advances to the fire and with his fore-feet beats upon it until it is extinguished, then retreats into the cave. When the bear cannot be driven out by smoke it sometimes becomes necessary for the hunter to take his rifle, and with a torch to enter the cavern in search of him. One would suppose this a very hazardous undertaking, and that the animal would soon eject the presumptuous intruder; on the contrary, as soon as he sees the light approaching he sits upright on his haunches, and with his fore-paws covers his face and eyes, and remains in this position until the light is removed. Thus the hunter is enabled to approach as close as he desires without danger, and, taking aim with his rifle, poor Bruin is slain. These facts have been stated to me by three different Indians in whose veracity I have much confidence, and I have no doubt are strictly true."

The Ainos, the probable indigenes of Japan, were once widely diffused, and their name for God is Kamui, meaning "flesh-strong." The bear was the great god of the Ainos—the good Deity who gave them much flesh. This animal is not only worshipped, but also killed and eaten by the primitive peoples, with much religious ceremony. As already seen, the Laplander pays Bruin a reverence little less than devout. The American Indian holds the bear in much reverence, making profuse apologies to the dead brute before he feasts on him. But albeit his apologetic efforts to propitiate the ursine manes, a grim humor will steal over the red man's devotion, for at the carrying away of his dead captive, should any "greenhorn" be present he will be asked to lend a hand by lifting at the tail.

There is still a dispute whether the Cinnamon Bear, *Ursus cinnamomeus*, is a valid species or not. Baird describes it as a variety of the black bear, a view worthy of general adoption. The hair resembles that of the black in texture. "The color is a nearly uniform dark chestnut or cinnamon, with a purplish reflection in certain lights; the hairs become, however, appreciably paler towards the roots." The animal is still common in the Rocky Mountain regions, occupying the same ranges with the grizzly and the black, though perhaps commoner southwards than they. A news item recently mentions the capture, by a party, of nine cinnamons in one day.

As to this variation of color,—in the Carolinas is the 'Yellow Bear,' doubtless the same species as the black. Robert Kennicott mentions an instance observed in Washington Territory, "in which four young were produced, part of which were black, and the rest yellowish brown." Says Halsey, the trapper, "The American black bear is of two kinds. One is short-legged, and has a heavy body, sometimes weighing five hundred pounds, and is black all over. The other is longer-legged, not generally so heavy, and has a brown face. This one is a great racer." De Kay says.

the long-legged and the short-legged appearance is due to condition of the animal, one being plumper in flesh than the other. Speaking of his two tame black bears, cubbed by the same dam, says Henry Clapp, "One was what is called the 'ranger bear,' that is, it was long-legged, and long-bodied, and not so black, and with a little coarser fur than the other variety. The other was what is called a 'hog bear,' and was shorter-legged and blacker. So I am sure the hog bear and the ranger are one species." But Clapp was



FIG. 179. — *Ursus horribilis*, grizzly bear.

a highly intelligent hunter. On this subject, trappers as a class are very positive. In fact, the "native woodsman wild" has his dogmas, and is himself a set dogmatist. Thus one of them delivered himself: "'Tain't no use argyin' this p'int. These two b'ars arn't sim'lar, nor no ways identical."

The Grizzly Bear, *Ursus horribilis*, is doubtless the most formidable of all the bears. He is the largest of the family, sometimes attaining a length of nine feet, and weighing eight hundred pounds. His coat is brownish or grizzly-gray. The long claws are sharp, chisel-edged, or gouge-shaped, and of great efficiency, both for tearing his prey

and digging. It has a shambling, cantering gait, the head swaying from side to side. The limbs indicate great strength. There is considerable range of color, the fur varying from brown to almost black, and on the other extreme almost to white. "His haunts are the Rocky Mountains, and the plains eastward; he is also found westward as far north as latitude 61°. His principal food is flesh, but he eats vegetables also. It is asserted that no animal will venture to touch a deer that has been killed and left by him. His strength is such that even the powerful bison falls an easy prey, and a single blow from one of his paws has been known to remove the entire scalp from a man's head. He is the only member of his family that will venture to attack man unchallenged, but it is said that he will retreat at the scent of a man if he can do so unobserved. He has attributed to him a peculiar habit of digging a pit for his fallen prey, in which he covers it over with leaves and rubbish. Hunters knowing this habit have saved their lives in desperate cases by feigning death without wounding the bear, escape being made while the latter is engaged with some other object. He is so tenacious of life that, unless shot through the heart or brain, his body may be riddled with bullets without fatal effect. One which had received two bullets through his heart, besides eight in other parts of his body, survived more than twenty minutes, and swam half a mile. The grizzly is not easily tamed unless captured at a very tender age, and even then he is rough in habits, and dangerous as a pet."

We saw two young grizzlies once in Central Park, which were very amusing. They would stand up on their hind-legs, embrace each other, make believe bite, and wrestle, then tumble and roll in a decidedly entertaining way. While thus engaged a child came to the cage with cake in its hand, and instantly the two seemingly innocent and good-natured things became two infantile fiends pure and simple. Their cry was sharp, metallic, and piercing, and most ferocious, as they snapped at each other in a contest to get nearer to the cake against the cage.

It is remarked that where the grizzly and the black bear abound the former avoids the latter. It must be that the greater beast has sufficient regard for his smaller cousin to wish him no harm, as he surely does not shun his black relative from any fear. It is almost certain that the only beast of which it entertains a wholesome dread is the puma or American panther, *Felis concolor*. This lithe beast, weighing full-grown perhaps one hundred and fifty pounds, is the terror of the grizzly, for through sheer liteness and agility this great cat can vanquish this terrible bear. The Indians say that they sometimes find a grizzly killed by a panther, but have never found a panther killed by a grizzly. To the Indian the grizzly is desirable for his flesh and pelt. The fact that to hunt him involves danger and adventure is now making the grizzly game for the white man.

The last to be noticed of the true or typical bears is the Polar Bear, *Thalassarctos maritimus*. The color is a silvery or creamy white. Its physiognomy differs strongly from that of the other bears. It has the longest neck of any, and the facial angle is almost a straight line. "The crown, forehead, and muzzle lie in one plane. The claws are black, in strong contrast with the white fur. The soles are very long. The length of the brown bear's sole is one tenth of the whole length of the animal. That of the polar is as one sixth. It is also thickly covered with fur, which gives a large unslippery surface to be applied to the ice, a prime necessity to the beast when hunting seal. As it hunts seal, and even fish, the use of its neck, so much longer than that of any in the family, is apparent. It is capable of great rapidity of movement." "One was observed to dive from a block of ice and capture a passing salmon. The seal is

basking on the ice. The bear at a proper distance quietly enters the water swimming towards its prey, keeping well below, and only occasionally allowing the nose to touch the surface sufficient to catch a breath. At last it rises just beneath, and in front of the seal, whose capture is certain, for if it fall into the water it will be caught, and movement landward is too slow to secure escape." "The pregnant females hibernate, the males and other females do not. She scrapes a hole in the snow, where buried she



FIG. 180. — *Thalassarcos maritimus*, polar bear.

brings forth her cubs, generally two." The maternal affection of the polar bear has long furnished the stock anecdotes on this subject. Indeed there are instances which are truly affecting. The mother will not desert her cubs, however great the peril to herself, and should they be killed first her manifestation of grief is truly touching.

The polar bear is the only aquatic member of its family. Practically it is confined to the Arctic zone. If it ever gets south of this region it is only as an unwilling passenger on some immense treacherous mass of ice. It is almost certain that they did come southward in this way oftener in the olden time. A en cites the account of

Jacques Cartier's voyage to Newfoundland in 1534. "In his account of the 'Island of Birds,' situated off the coast of Newfoundland, it is stated, 'And albeit the sayd island be fourteen leagues from the maineland, notwithstanding beares come swimming thither to eat of the said birds, and our men found one there as great as any cow, and as white as any swan, who in their presence leapt into the sea, and upon Whitsunday (following our voyage to the land) we met her by the way, swimming toward land as swiftly as we could saile. So soone as we saw her we pursued her with our boats, and by maine strength tooke her, whose flesh was as good to be eaten as the flesh of a calf of two yeares old.'"

Nine feet in length is accounted large even for a polar bear. Hence, but for its minuteness of statement, the following as to length and weight would seem incredible. At any rate it is quite a match for Jacques Cartier's specimen "as great as any cow." "A party of men from the *Isabella*, including a number of Eskimo and myself, were walking on the ice a short distance from the ship, when, rounding a hummock, we unexpectedly discovered, a short distance from us, a large bear quietly feeding. We would have returned to the ship without disturbing it, as we were armed with only one rifle and a few spears carried by the natives, had not one of the several dogs that were with us announced their presence by a loud bark. The bear, as soon as it saw the intruders, began to advance slowly toward us, but was met by the dogs, who attacked the animal vigorously but with little effect. He shook them off, and after injuring three of them so badly that they had to be killed, he continued to advance. We discharged the rifle and then fled to the ship, where we armed ourselves and came out to look after the bear, which had disappeared behind one of the numerous hummocks by which we were surrounded. We had searched for some time when as one of the Eskimo passed the corner of a hummock he came face to face with the infuriated animal. He gave a fearful cry just as the brute struck him with one of his immense paws. The rest of us heard the cry and rapidly surrounded the brute, which stood perfectly still over the body of the Eskimo. We fired sixteen shots, twelve of which entered his body, before he received his death wound. The native was insensible when we picked him up, and badly torn about the shoulders by the beast's claws, but was not seriously hurt. We took the body of the bear on a sledge to the ship; it weighed fifteen hundred and seventy-five pounds, and was ten feet and one inch from nose to tail, and eight feet and four inches around the thickest part of its body."

A writer in "*Blackwood's Magazine*" narrates an incident of which he was an eye-witness, which sets the young of the polar bear in a very attractive light. "My first acquaintance with the white whale in the flesh was made on the 'snow-foot' at the base of the cliffs below the Samoyede settlement at the head of Karmakula Harbor, having previously encountered by the hundred their mouldering skeletons scattered along the beach in various parts of the island, picked remarkably clean by the burgomaster or glaucus gull, that greedy scavenger of the arctic regions. On the stretch of snow-ice in question, there were ranged the bodies of half a dozen white whales, varying from six to sixteen feet in length. Hearing a snarling sound behind one of the carcasses, I went up to discover the cause, and was surprised to see a young polar bear making off with a large piece of offal in his mouth, and smeared from head to foot with gore, grumbling loudly to himself as he shamled off at having been disturbed at his meal. We afterward came upon this bear having his dessert in the Samoyede cooking-tent, surrounded by a group of admiring and envious Eskimo dogs, with whom he appeared to be a great favorite, on the whole. Having finished his food, and then

licked one of the dogs from head to foot — perhaps by way of cleaning his tongue — he adjourned to the Samoyede living-tent, where he speedily settled down among the children and furs, and went peacefully to sleep.”

The polar bear has been regarded as an absolute carnivore. The journal of the Eira shows that they eat marine grass in large quantities. In confinement they like mixed diet, even cocoa-nuts, in connection with which the following interesting manifestation of intelligence was communicated to “Nature”:—“In the Clifton zoological gardens there are two female polar bears, between two and a half and three years old, which came here quite young. A cocoa-nut was thrown into the tank; it sunk a long way, and the bear waited quietly till, after some time, it rose a little out of her reach. She then made a current in the water with her paw, and thus brought it within reach. This habit has already been several times noticed in polar bears. She then took it on shore, and tried to break it by leaning her weight on it with one paw. Failing in this, she took the nut between her fore-paws, raised herself on her hind-legs to her full height, and threw the nut forward against the bars of the den, three or four feet off. She then leaned her weight on it, hoping she had cracked it, but failed again. She then repeated the process, this time successfully. The keeper told the writer she employed the same method to break the leg-bone of a horse. That this is the result of individual experience, and not of instinct, is clear from the fact that her companion has not learned the trick of opening them thus, nor could this one do it when she first came.”

We have now reached the third sub-group of the great group Arctoidea, namely the Arctoidea Musteliformia—the Weasel-bears. It would not be surprising if the reader should feel that the method we are following is somewhat arbitrary and unnatural, for we here find the otter, which needs a very great specialization of form for its food-procuring functions. Then, again, in the sub-family Mustelinæ, which will close this section of the weasel arctoids, we shall find the sub-plantigrade *Gulo*, and the weasel-like grison, quite plantigrade, and lastly the weasels and martens which, like the cat and the dog, are digitigrade. But Nature’s mysteries are beneath the skin, not outside. Her plan is in the bony skeleton. Although our weasel-bears differ much among themselves, “they bear, nevertheless, certain important characters in common, such as the structure of the ear-drum bone, which, in essential respects, resembles that of the bears, as also do the organs of digestion.” With more or less power of secretion we find, among the arctoids now to be considered, the possession of anal glands, reaching the highest development, for offensive and defensive use in the polecat of the Old World, and pre-eminently in the skunk of the New.

The family MUSTELIDÆ contains eight sub-families, which must be taken up in an ascending order.

The Enhydrinæ contains the Sea Otter, *Enhydris lutris*. It is in some respects not much unlike a seal, especially if its flipper-like hind-feet be considered. In the physical character of its teeth, as well as in the dental formula, *Enhydris* is peculiar in its family. “All the grinders are of a singularly massive, tubercular, almost bulbous character, with no trenchant edges, acute cusps, or even angular edges. This is in evident adaptation to the piscivorous regimen of the animal.” “The fore-feet are remarkably small, giving the limbs an appearance which suggests amputation at the wrist.”

A truthful account of the strange, vigilant life of the sea-otter, and of the hardships and perils encountered by its hunters, would surpass in novelty and interest the most attractive work of fiction. Saanach Island, islets, and reefs, in Alaska, form the great hunting-ground of the sea-otter. The island is small, with a coast-line circuit of about eighteen miles. The natives do not live upon the island, because the making of fires and the scattering of food-refuse alarms the otters, driving them off to sea; so that it is only camped upon, and fires are never built unless the wind is from the southward, for no sea-otters are ever found to the north of the island. The sufferings to which the native hunters subject themselves every year on this island, going for many weeks without fires, even for cooking, with the thermometer down to zero, in a northerly gale of wind, is better imagined than described.



FIG. 181. — *Enhydra lutris*, sea otter.

Says Elliott, "The adult sea-otter will measure from three and a half to four feet at most, from nose to tip of tail, which is short and stumpy. There is no sexual dissimilarity in color or size, and both manifest the same intense shyness and aversion to man, coupled with the greatest solicitude for their young, which they bring into existence at all seasons of the year; for the natives get young pups every month in the year. As the natives have never caught the mothers bringing forth their offspring on the rocks, they are disposed to believe that their birth takes place on kelp-beds, in pleasant, or not over-rough weather. The female has a single pup, born about fifteen inches in length, and provided, during the first month or two, with a coat of coarse, brownish, grizzled fur; head and nape grizzled, grayish, rufous white." The fur at two years is 'prime,' though the animal is not full-grown until its fourth or fifth year. The female has two teats, resembling those of a cat, placed back of the hind limbs on the abdomen, and no signs of more; the pup sucks a year at least, and longer if its mother has no other. The mother lies upon her back in the water, or upon the rocks as the case may be, and when she is surprised she protects her young by clasping it in

her fore-paws, and turning her back to the danger. They shed their fur just as the hair of a man grows and falls out; the reason is evident, they must be ready for the water at all times.

"The sea-otter mother sleeps in the water on her back, with her young clasped between her fore-paws. The pup cannot live without its mother. Frequent attempts have been made by the natives to raise them . . . but it seems so deeply imbued with the fear of man that it invariably dies from self-imposed starvation. . . . Their food is almost entirely composed of clams, muscles, and sea-urchins, of which they are very fond, and which they break by striking the shells together, held in each fore-paw, sucking out the contents as they are fractured by these efforts. They also undoubtedly eat crabs and fish, and the juicy, tender fronds of kelp. They are not polygamous, and more than one individual is seldom seen at a time when out at sea. They are playful, it would seem, for I am assured by several old hunters that they have watched the sea-otter for half an hour as it lay upon its back in the water, and tossed a piece of sea-weed in the air from paw to paw, apparently taking great delight in catching it before it could fall into the water. It will also play with its young for hours."

Next comes the sub-family Lutrinæ, or true otters, with that strange form the Wing-tailed, or Margin-tailed Otter, *Pteronura sandbachii*. This animal, though nearer the true otter than *Enhydryis*, is really so erratic a member of the Lutrinæ, that it rightly stands at the bottom of this sub-family. The conical tail has on each side a flange-like ridge, or expansion, a feature so strange as to make it very remarkable. Its home is Brazil and Surinam.

There are two accepted genera of Old World otters, chiefly remarkable for the smallness, or rudimentary condition, of their claws. These are the *Septonya* and the *Aonyx*. With this mention, these are dismissed, and we take up the typical otters, *Lutra*. Of this genus there are four species. As almost nothing is known of the habits of Mexican (*L. californica*) and Brazilian otters (*L. braziliensis*) we shall only deal with the remaining species.

The common otter of Europe (*L. vulgaris*) has really a history of its own. Due to its aquatic habits, and maybe to its fishy taste also, it was formerly held by ecclesiastics to be half flesh and half fish, and in some such way the conscience was eased by this casuistry, so as to rule otter out of the flesh lists into the fish lists on fast days. Illustrative of this, Izaak Walton is often quoted, who has a quaint dialogue on the subject, from which it appears that the question, whether the otter be "a beast or a fish," "has been debated among great clarks, and they seem to differ about it; but most agree that his tail is fish."

The old world otter is about two feet long from tip of nose to base of tail, the latter organ being about seventeen inches long. Its fur is soft, and its predominant color brown, but lighter under the throat and the breast. Between the nostrils is the nasal pad, a small spot compared with that on the American species. The skull has strong points of similarity to that of the seal. The naked soles and palms, with the round ball on each, make a series of clean impressions in their haunts, which betray them to the hunter. Their nesting spots are always near the water, in a hole in the bank, or under the roots of a tree, which they contrive to bed with rushes, grass, and weeds. They produce four or five young in the spring, and it would seem that the mother has to exert herself to teach her charge how to fish, in a word, she must bring them up to get their own living.

In some parts of Europe otters are still trained to fish. In China this is quite common. Bishop Heber gives, in his journal, an account showing that tamed otters, probably *Lutra nair*, were used for fishing in India. "We passed, to my surprise, a row of no less than nine or ten large and very beautiful otters, tethered with straw collars and long strings to bamboo stakes on the banks (of the Matta Colly). Some were swimming about at the full extent of their strings, or lying half in and half out of the water; others were rolling themselves in the sun on the sandy bank, uttering a shrill whistling noise, as if in play. I was told that most of the fishermen in the neighborhood kept one or more of these animals, who were almost as tame as dogs, and of great use in fishing; sometimes driving the shoals into the nets, sometimes bringing out the larger fish with their teeth. I was much pleased and interested with the sight. It has always been a fancy of mine, that the poor creatures whom we waste and persecute to death, for no cause but the gratification of our cruelty, might, by reasonable treatment, be made the sources of abundant amusement and advantage to us." Perhaps it may give point to the words of the good bishop to add, that this animal, made so admirably subservient to man, is, in its wild state, when attacked by dog or man, savage and formidable to a degree.

The American Otter (*L. canadensis*) differs from that of Europe mainly in its larger size, as it attains a length of considerably over four feet, the tail being about half the length of the head and body. It differs also markedly in the fact that in part its soles are furred, and have callosities. But a singular difference from all other otters consists in the large, pentagonal nose-pad, aptly likened as to form by Coues to 'the ace of spades.' Beneath the root of the tail are two glandular eminences. Our otter is said to litter about the middle of April, producing from one to three young ones. As the animal has a range over nearly all the temperate zone of North America, the time of its littering must differ with location.

In many localities in the west, where the position and character of the soil favor, are places known as 'otter slides.' If it be a steep slope, and a slippery clay soil, the otter delights in sliding down to the stream. Describing what he saw, says Audubon, "The otters ascend the bank at a place suitable for their diversion, and sometimes where it is very steep, so that they are obliged to make quite an effort to gain the top; they slide down in rapid succession where there are many at a sliding place. On one occasion we were resting on the bank of Canoe Creek, a small stream near Henderson, which empties into the Ohio, when a pair of otters made their appearance, and, not observing our proximity, began to enjoy their sliding pastime. They glided down the soap-like, muddy surface of the slide with the rapidity of an arrow from a bow, and we counted each one making twenty-two slides before we disturbed their sportive occupation."

For American boys, coasting down hill on the snow is almost a national pastime, and has in it a large amount of sport and excitement. It is curious that our American otter should have antedated this boyish pastime; for this animal has his own fun on this line when the snows of winter permit. Otter coasting on the snow has been witnessed by many. Richardson, one of the earliest observers of this habit in the otter, speaks of the animal as resorting to this dodge to escape the hunters. "This movement is repeated with so much rapidity, that even a swift runner on snow-shoes has much trouble in overtaking it. It also doubles on its track with much cunning, and dives under the snow to elude its pursuers. When closely pressed it will turn and defend itself with great obstinacy." Godman gives the method of the game: "Their

favorite sport is sliding, and for this purpose, in winter, the highest ridge of snow is selected, to the top of which the otters scramble, where, lying on the belly with the fore-feet bent backwards, they give themselves an impulse with their hind-legs, and swiftly glide head-foremost down the declivity, sometimes for the distance of twenty yards. This sport they continue, apparently with the keenest enjoyment, until fatigue or hunger induces them to desist."

Audubon speaks of four American otters which a gentleman had tamed so completely that they never failed to come like dogs when whistled for, crawling slowly with apparent timidity towards their master. He also gives his own experience in domesticating several otters, which became so tame that they would romp with him in his study. These, he says, were taken when quite young, and became as gentle as puppies in two or three days. They preferred milk and boiled corn-meal, refusing fish or meat till they were several months old.

The sub-family Helictidinae contains four species, ranging from Nepal to Java, Formosa, and Shanghai. *Helictis nepalensis*, which is confined to the eastern Himalayas, is a slender little animal, though rather long-bodied, even for a weasel. It has quite a long tail, which is as bushy as the brush of a fox. The marking is curious. The ground color of the pelt is a dark gray-brown, with a distinct white line, running from the neck, on the middle of the back, to the tail. A white band goes from the throat on both sides nearly to the back, connected with which is a great white patch, covering the throat and chest, and extending underneath, giving to the queer little beast a look of demureness as if arrayed in a baby's bib. *Helictis* is a genus of the weasel family exclusively oriental.

Allied in form to the last are the Zorillinae, and similarly connected with the rats and badgers. Such, however, is the offensive energy of the secretion of the anal glands, that the Zorilla or *Ictonyx* may deservedly be called the African Polecat. There are two species, ranging from tropical Africa to the Cape, says Wallace, though it is elsewhere said to extend through northern Africa into Asia Minor. *Ictonyx zorilla* has habits very much like those of the common skunk in its destroying small animals. But the zorilla is in part arboreal, hence also destructive to birds and their eggs. It is a determined enemy of poultry, and entails great loss to the inhabitants of the districts where it is found. It is often tamed and used to destroy rats and mice. The fur is shiny, and the prevailing color black, with white bands and spots. The tail is similarly marked and about eight inches long, the body being about twelve and somewhat stout. The snout is elongated as with the South American skunk.

This brings us very naturally to the Mephitinae, or skunks, "a sub-family confined to America, its nearest Old World representatives being the African Zorillinae." "Form stout, tail very bushy, pelage long, colors black and white. Habits strictly terrestrial, more or less fossorial, progression plantigrade, movements slow. Size moderate and small, no peculiar subcaudal pouch. Perineal glands extraordinarily developed, affording a means of offence and defence."

We might, when introducing the great family Mustelidæ, have dwelt upon the most striking physiological phenomenon in the group, that capacity of secreting and discharging, for offensive and defensive purposes, a fetid substance. Any consideration of this peculiarity will be, we think, better understood now that we have reached those animals in which this singular capacity is the most largely developed, namely, the Mephitinae. Upon the possession of these odoriferous glands, M. Chatin attempts a classification of the whole family. He says, "Including such different animals as the

otter, polecat, badger, skunk, marten, and ratel, it is indeed a heterogeneous family of the Carnivora. Milne-Edwards was enabled to form three families out of the components of so miscellaneous an assemblage as that of the Mustelidæ. In the configuration of the limbs, as well as in their entirely peculiar habits, the otters would represent the Lutridæ, the weasels and polecats the Mustelidæ, while the Melidæ would embrace the skunks, badgers, etc.

"Now these three divisions correspond with as many modifications of the perinæal secretory apparatus; the two former, Lutridæ and Mustelidæ, offer, in a general way, a single pair of glands opening on the border of the anus, one on each side, furnished with a receptacle for the product of secretion.

"In the Melidæ, the badgers on the one hand, and the skunks and the ratels on the other, form two quite distinct sections. In these latter genera are likewise found a single pair of anal glands, but these are quite different from those of the Mustelidæ. The receptacle has a remarkable capacity; the follicular mass, instead of spreading over it, occupies but a small portion of its surface, while the secretion, which is always plentiful, here acquires an unparalleled fetor. In the badgers, on the contrary, these anal glands are not the only secretory organs, there being in addition a particular subcaudal pouch surrounded by a racemose gland, which produces a peculiar liquid."

The above sheds light on the physiology of the strange habit to be soon mentioned in some of these animals. But, as Coues well remarks, M. Chatin does not give due weight to other features of structure. Hence we may adopt for our course the words of Dr. Coues when he contends that the Mustelidæ, as he gives it, is a homogeneous and natural assemblage of genera, etc.

The Mephitinæ is a small group possessing, as now known, three genera in an ascending order, *Spilogale*, *Mephitis*, and *Conepatus*. This last name is, in scientific nomenclature, a barbarism, derived from the local Mexican name, Conepatl. The anatomical details of difference would weary the ordinary reader. Scarcely more than mention can be made in a general way of the pelage of the three genera. It may be said that the ground color of all is black, or blackish, and that in all the genera, though sometimes it is nearly obsolete, is a narrow, white stripe in the middle of the face, reaching to the nape, and there widening into an area more or less pronounced. *Spilogale putorius*, the Spotted Skunk, is the smallest of the skunks. The pattern of its pelage is the most varied, and its fur is shorter and softer. Coues says its "fantastic, harlequin-like coloration is scarcely duplicated in any two specimens." The fore-part of the upper surface has four parallel white lines. There are three white bead spots. Those and the above-mentioned lines are the most constant, for it often has other spots and lines. In its normal marking, on a bright black ground, *Mephitis mephitis*, the Common Skunk, has a white patch on the forehead which, going up and back on the nape, divides into two white bands, reaching to and even meeting at the tip of the tail. In *Conepatus mapurito* of South America the skunks attain their largest size; the fur is coarse and harsh. The two white dorsal bands often unite and make one broad white surface. The tail is not bushy, but relatively the hair is short and close. The snout is extended, as if for rooting, and the face has a piggish look, while the animal has much the contour of the badger.

Better knowledge has greatly reduced the number of the species. We have instanced the best known species in each of the three genera, and as the most striking characteristic in habit of the Mephitinæ is that one which gives the family its malodorous reputation, it will suffice to take up the history of but one species. For this

purpose the typical one in this group must be selected, which is *Mephitis mephitis*, the common American skunk.

Without this provision for casting at its enemy this fetid liquid, the skunk would be feeble and almost defenceless, in fact pitifully helpless for resistance or escape. Run fast it cannot, nor can it like the weasel retreat to small holes, nor can it climb or swim except with great effort. Almost everywhere one hears the vulgar and absurd statement that the animal urinates on its tail, and then flirts the vile liquid in a mop-like manner at its enemy. Says one, "This is all plain enough, I have often seen it; because the animal always raises its tail high up at the precise moment of flinging the stuff." The fact given is correct, but the reason assigned is wrong. The tail of the skunk is a beautiful member. In the bushiest-tailed examples the hairs fall loosely all around when the tail is elevated, like the plumes of a pompon. Do not animals have personal pride? The writer thinks some do. The skunk is a very clean creature, never in any way defiling itself. Let us look at the mechanism of this ejection, and see. As shown already, the animal has a pair of secreting glands, one on each side of the vent. "Each gland is a secretory sac in a muscular tunic, and is furnished with a duct to convey the secretion to a little teat-like pipe near the verge of the anus. Contraction of the muscular investment compresses the sacs," and spurts, for eight or ten feet distant, the fluid in two jets. The action is really the same as that of a syringe with compressible bulb. It is noticeable that this instinctive effort to get the tail out of the way of the jets is necessary for the bringing about of the ejection. The very action of lifting the tail pulls upon a set of muscles, and thus helps to compress the sacs containing the fluid. Such is the cleanliness of the animal that it is almost certain that the ejection is never made except for defence, or for a sexual call, or to relieve itself when the secretions have become excessive. When discharged, the animal is harmless for a time. "To the eye the peculiar and odoriferous secretion of this animal is of a pale bright or glistening yellow, with specks floating in it."

The odor can be perceived a mile or more off. It is powerfully penetrating and disgusting. When brought suddenly near the fluid some persons will suffer severe nausea, and dogs who get it upon them have been known to vomit. The smell is dreadfully persistent.

If the liquid gets into the eyes it is intensely irritating. Indians say some of them have been made blind by it. Full a mile from our residence, a small stream crossed the road. A fisherman was going home late at night intoxicated. He saw, as he thought, a cat crossing the road right before him in a very leisurely way. In maudlin goodness he stooped to talk to it, — "Poor pussy! pretty puss!" — when a yell, which made "the welkin ring," burst from the poor fellow. It was a skunk, and he had got shot full in the eyes. For the time the man was absolutely blind, and with agony he got into the stream, unable to find his way. Help came, and he was taken to a house, and the eyes washed in cold water. He suffered, to use his own words, as if he had "red hot melted lead in his eyes." The man was old, and the strange thing was that when he got over his distress, his eye-sight was greatly improved, and so continued. A farmer friend, who had a little A-shaped coop in the barnyard to which a hen resorted with her brood of chickens each night, one day missed the hen. In the coop, it was found, was a skunk. He had feasted on the mother, and was hovering over the little ones, which seemed to enjoy the furry retreat; and, as his wants arose, he helped himself to one or more of his foster charge. The farmer got his gun. Then there was a hooting to get the beast started. The animal, as was its wont, began to move

very leisurely. Out came the head slowly from the coop. The farmer fired, blowing the head to atoms. There was no smell. The animal had no chance. The skunk is to-day exceedingly abundant in the great West. I am told of the occupants of a ranch in Colorado being driven out by them. Even in Nebraska the engineer is sometimes driven from his engine by having picked up the stupid animal off the track into the ash-pan, for the silly thing will not run away, even from a locomotive.

That which was long known to the Indians is now accepted, that the skunk bite can inflict hydrophobia. Helpless as this little brute is for escape when pursued, it can show fight worthy of itself. Why, however, it should be capable of two such inflictions does not appear. Can it be that the capacity to inflict hydrophobia is because of some inability to secrete the liquid, thus making the animal ill? It yet remains, however, to be ascertained whether the beast ever goes mad like a dog.

The skunk spends the winter in burrows under ground in a semi-torpid state, being very fat when retiring. The female has from six to nine young at a birth, which keep to the burrow until able to take care of themselves. The skunks burrow with rapidity, making their hole some two feet below the ground, and five to seven feet long; at the end a chamber is made, in which is placed a bed of soft grass. Sometimes the chamber is occupied by a number of individuals. Says McChesney, "The fact is that the skunk is not nearly as bad an animal as some people would have us believe. In his way, which may be humble, he is capable of and does much good. He is insectivorous to a remarkable degree, consuming vast quantities of insects that are injurious to vegetation. Instances of his kindness might be cited in proof of his often genial disposition; and he only follows the coarser instincts of his nature when molested, and for this surely the animal is not to blame. But, under such circumstances, I must confess I prefer to admire him at that safe distance which lends enchantment to the view."

The sub-family Mellivorinæ contains the ratels, or honey badgers. They surpass the skunk in burrowing activity, and possess a similar battery of defence, though the odor is not quite so pungent. They are about twenty-eight inches long, body and tail, the latter being about five inches. The face, and all the lower parts, and the tail are black, while the top of the head, and the entire back, are of an ashen-gray. This gives to the animal the appearance of wearing two kinds of furs, in fact, an old gray cloak. The ratels belong to the genus *Mellivora*, the Honey Eaters. There are three species, two belonging to southern and tropical Africa, and one to Hindostan. Of the habits of the species in tropical Africa less is known than of the Cape Ratel, *Mellivora capensis*, and the Indian Ratel, *M. indica*. The animal is really a skilful bee-hunter. The human bee-hunter will lie on his back so as to see the bees fly in the sky, and thus will get the "bee-line." It is asserted that the ratel takes observations of the insects on the wing, choosing the most eligible places for that purpose, where, seated on its hind-legs, and shading its eyes with one of its paws, it makes its observations. There can be no doubt that, when robbing the bees, the honey thief does get some punishment. Still it has a sort of immunity. The skin is thick, and flabby, or loose, and underneath is a layer of thick adipose, or almost nerveless fat. The two Parkers give a curious instance of habit observed in a ratel in Regent's Park. "It would run round and round in its cage. When it reached a particular corner of the den, quietly and without effort it would turn over head and heels, and then move on again. On one occasion, after it had been doing this with great regularity for some rounds, it seemed to become abstracted, and passed the usual spot without the somersault. When, however, it had proceeded a few paces, it seemed to recollect itself, and stopped for a

moment, then returned to the exact place, turned over as usual, and proceeded without further let or hindrance."

"Animals of the sub-family *Melinæ* inhabit Europe, Asia, and America. There are four well-marked genera, though the species are so few: the European *Meles*, the Asiatic *Mydaus* and *Arctonyx*, and the American *Taxidea*, long time confounded with *Meles*."

The *Arctonyx collaris*, ranging from Nepal to Aracan, is one of the Asiatic badgers. Its Hindostanee name is Balloo-Soor, the Sand-Hog. Though somewhat like the typical badger of Europe, it stands much higher on its legs, and has a rather inordinately long snout. In fact, it looks more like a bear. The claws are well fitted for burrowing, and the toes are united through their whole length. The tail is very short. Its food is both animal and vegetable, and the animal is said to be very fierce. The prevailing color of the pelage is yellowish white.



FIG. 182.—*Mydaus meliceps*, teledu, stinking badger.

The Teledu, *Mydaus meliceps*, the Stinking Badger, is confined to Sumatra and Java. "It is only found on mountains with an elevation of over seven thousand feet. Hence for these cold altitudes its fur is warm, being long, and closely set, and silky. The prevailing color is a yellowish white. It is a little more than a foot long; has a pig-like head, a stout body, very short legs, and a stumpy tail not more than an inch long. The feet are plantigrade." The claws of the fore-feet are nearly twice as long as those of the hind, and being curved, and the legs strong, the fossorial ability of the animal is great. It has the power of ejecting a highly fetid liquid, like the skunk. It burrows by day, and in the night roots and scratches for worms and insect larvæ.

The Common Badger, *Meles vulgaris*, is well known in Great Britain, and over a large part of Europe. The genus containing allied species is found in Asia. The sport of badger-baits is an old one, and many a dog has come to grief in these contests from the sheer ferocious pluck of the persecuted animal. On the lower parts of the body the hair is short and black; above, it is long, coarse, and of a rusty gray. The badgers seem to be monogamists, and to occupy one burrow, which they themselves make in the ground, lining it with grass, and replenishing the bed as need arises. Here the young are brought forth, usually about three or four, in early summer. "The badger,

like the bear, treads upon the whole heel, and its walk closely resembles that animal. They caress each other in the same grotesque manner while they gambol and play, and at times they utter a cry so loud as to startle any one ignorant of its source. They dress their fur-like coats, or do kind offices for each other, and search for parasites after the manner of the monkeys." Like others in the group they will make ventures for the contents of a wasp's nest.

We now come to our American badgers, which differ so much from all the Old World species as to be set into an entirely distinct genus. Baird's diagnosis of *Taxidea americana* is thus: Body extremely stout, squat, and clumsy, owing to great depression; tail short, broad, and flattened; pelage loose; coloration diffuse; fore-claws extremely large, highly adapted for digging. Habits thoroughly terrestrial and fossorial. It is confined to North and Middle America. The prevailing color is a blackish tawny-gray and white, which produce a general grizzle. West of the Mississippi the badger abounds, and lives much on the small rodents. It is timid in that it shuns man, and though caught by the trapper is very rarely seen alive. Brought to bay, however, it is a plucky beast. "The snap of the jaws inflicts a serious wound, and the tenacity of life is at a high rate."

Dr. J. S. Newberry narrates his own experience with *Taxidea americana*. "In traversing the arid surfaces of the sage plains of eastern California, Utah, and Oregon, there is, perhaps, no one thing which the traveller may be more sure of seeing every day of his journey than the burrow of a badger; and after cursing the country, and the folly which led him to cross these barren, hot, and dusty surfaces, there is nothing he will more certainly do, whether on foot or mounted, than tumble into one of these same badger-holes, and yet the chances are more than equal that he never sees a living badger on which to revenge himself, for the badger is a timid animal, and the country he inhabits is so open, it rarely happens that he is surprised at a distance from his burrow.

"Mr. Anderson came one day suddenly upon a badger at some distance from his hole. Of course he made for it with all possible speed, which, it should be said is not so great but that a man could easily overtake one. Mr. Anderson at first endeavored to trample him under his horse's feet, but though he ran over him several times the badger avoided the hoofs, and received no injury. He drove his horse before him, and brought him to bay. He then jumped off, hoping by means of kicks and his sheath-knife to dispatch him; but the badger, instead of retreating, came at him open-mouthed, and with such a show of ferocity, that he was fain to let him pass, and before he found any sort of stick the badger had reached his hole."

Says Coues, "The badger, above all our other animals, is notable for its *flatness*; even when running it looks broad and flat, and the belly seems to sweep the ground during its rather slow, heavy, and awkward progress. Seen when crouching in fancied security, or hoping to escape observation (and it will sometimes remain long motionless in this posture, permitting near approach), the animal might easily be mistaken for a stone or clod of earth. The very hairs lie flat, as if parted in the middle, and form a fringe along either side, projecting, as one writer has remarked, like the shell of a turtle, or the eaves of a house. The peculiar pattern of coloration is then displayed to the best advantage. Under anger or irritation the animal bristles up its hair, and appears much larger than it really is."

In the gopher communities the badger lives in clover, as he occasionally helps himself to a spermophile by digging him out with astonishing celerity, and if the notion

seizes him, having eaten the occupants, he will take possession of the premises, and enlarge the establishment to suit his own ideas of convenience. In confinement the badger will put up with a mixed diet, but it prefers flesh. No American animal enjoys the immunity that the badger does. Man only is its successful enemy. Its great strength, and its burrowing facility, secure it from the wolves; and the poor rodents afford it abundant food. In high latitudes, for the severest part of the winter, it hibernates.

We have now reached the last sub-family, the Mustelinæ. Though still related to the bears, this last sub-group is getting away from them, so to speak, in the direction of the higher carnivores, even attaining, when the group is completed, to some extent the toe-stepping and claw-retractile endowments of the cats. In the Mustelinæ the "toes are short, regularly arched, and with the last phalanges bent up, withdrawing the claws into sheaths."

The Wolverine, or Glutton, *Gulo luscus*, has a circumpolar distribution in both hemispheres. "The form of this animal indicates great strength without corresponding activity. The body is heavy and almost clumsy, supported upon thick-set and rather low legs; the walk is incompletely plantigrade. The back is high-arched, the general figure drooping both before and behind, both tail and head being carried low. The general appearance is strikingly that of a bear cub, with the addition of a bushy tail. The jaws are rather canine in appearance." The prevailing color of the animal is blackish, that of the Siberian being a deeper and glossier black gives more value to the fur. The discharged secretions are highly fetid. It must be admitted that *Gulo* is voracious. When prey is in plenty he will gorge himself, and then will hide the rest. But the old authors and artists did astonishing things for *Gulo's* reputation. This clumsy, huge, misshapen marten could run up trees like a cat, and spring upon a deer and dispatch it, not excepting the great moose or elk, and if the deer were not so obliging as to put themselves in position, *Gulo* was artful enough to drop down tempting bait to entice them, such as leaves, moss, etc., and when this failed, the wily fellow would wheedle the foxes to drive the deer under the tree where he lay in wait. For big-eyed imagination perhaps Olaus Magnus, in 1562, deserves the palm. But this quaint ancient must be allowed to speak for himself. "It is wont, when it has found the carcase of some large beast, to eat until its belly is distended like a drum, when it rids itself of its load by squeezing its body betwixt two trees growing together, and again returning to its repast soon requires to have recourse to the same means of relief." Coues instances an effort of one of the old artists in a zoological work to show how all this was done, in "a very droll picture of a wolverine squeezing itself between two trees, with a most anxious expression of countenance, the fore part of the body being pressed thin, while the hinder is still distended, and the large pile of manure already deposited being rapidly augmented with further supplies." These old writers only knew the animal in his haunts in northern Europe and Asia.

Strange to say, even Linne libels the animal in giving it the specific name *luscus*, 'one-eyed,' as if it were some troglodytic Polyphemus among beasts. Forsooth the first wolverine taken to Europe from Hudson's Bay happened to be a poor unfortunate, minus one "optic," hence the sage deduction that the wolverines were a one-eyed tribe. Still, *Gulo* is crafty, and not without guile. To his sorrow the trapper knows that despite his small eyes he sees too much. He will follow the 'marten roads' for many miles, and steal the catch from the fur-hunter's traps. Should a trap be set for him he will undermine it in the snow, spring it, and take away

the bait. He has a circumspection of his own. Game exposed for one night has been visited by the glutton and left untouched. Should it be left a second night he will gorge himself, dismember what is left, and bury the parts under the snow in different places, then defile the spots, so that other animals may regard these stains as cards of caution that their much dreaded enemy is about,—some say that it is by dint of the greater smell to cover up or mask the smell of the buried meat. As a burglar he is desperate



FIG. 183.—*Gulo luscus*, wolverine, glutton.

and villainous. In breaking into a *câche* "he has been known to gnaw through a log nearly a foot in diameter, and also to dig a hole several feet deep in frozen ground, to gain access to the coveted supply. Should he succeed in gaining entrance, and yet be unable to displace the logs sufficiently to permit of removal of the meat, the brute will defile it, so that even a dog will scarcely touch it."

And *Gulo* is an inveterate thief; he delights in larceny for the simple fun of it. Besides destroying marten traps, he will carry off the several parts to a distance, and hide them for sheer malice. "A hunter and his family, having left their lodge

unguarded during their absence, on their return found it completely gutted—the walls were there but nothing else. Blankets, guns, kettles, axes, cans, knives, and all the other paraphernalia of a trapper's tent had vanished, and the tracks left by the beast showed who had been the thief. The family set to work, and by carefully following up all his paths, recovered nearly all the lost property."

"They bring forth in burrows under ground, probably old bear wastes, and have four or five young at a birth. They reproduce late in June, and early in July. The pairing season is in March. The female is ferocious in defence of her young. Indians have been heard to say that they would sooner encounter a she-bear with her cubs than a Carcajou under the same circumstances. The Onondagas call *Gulo Gwing-gwah-gay*, which means 'a tough fellow,' a 'bad character.' In October, when the rivers set fast, the wolverines reappear in families, the young still following their dam, though



FIG. 181. — *Galera barbara*, tayra.

now not much her inferior in size. They are full grown when about a year old. In early infancy the cubs are said to be of a pale cream color." Seeing a man in the distance, as if to make assurance doubly sure, the wily carcajou has been seen to sit on its haunches, and shading the eyes with one paw, to take deliberate observation in the way adopted by men. As we have already said, Sparrman affirms a similar human accomplishment of the bee-hunting ratel.

The Grison, *Galictis vittata*, was formerly described as the South American Glutton, *Gulo vittatus*. It is a very different animal. The wolverine is semi-plantigrade, the grison is fully plantigrade. It is a weasel-like form, peculiar to South America. Its fur, unlike the martens and weasels, is light above and dark below, the colors being gray and dark brown. It is about two feet in length, besides the tail, which is about one foot long. "It is found in plantations, and in the neighborhood of buildings, and makes its abode in hollow trees, clefts in rocks, and holes in the earth."

The grison's immediate cousin is the Tayra, *Galera barbara*, found from Brazil and British Guiana to Paraguay. The entire length, including the tail, is about three feet,

the latter being nearly the half of the whole length. With a yellowish spot below, the upper part of the body is a blackish brown, but lighter on the head and neck. It preys upon small mammals and birds in the forests, hunting in the morning. Say the Parkers, "This animal is one of the ugliest in the whole carnivorous order. It is not unlike the marten in shape, but with a low, villainous, and almost debauched expression of face." The tayra, like its cousin the grison, is a plantigrade.

We have now done with the plantigrades, and are come to those animals of the Mustelinæ which are digitigrade, or toe-steppers. It contains quite a number of species, more than we have room to mention, and formerly all were included under two genera, *Mustela*, the martens, and *Putorius*, the weasels. But while *Mustela* holds its own, *Putorius* has been badly cut up into sub-genera, such as *Lutreola*, the little otters, namely, the minks, so-called from a fancied resemblance, and *Gale*, the weasels, etc. For the sake of avoiding confusion, we shall not discard the older genus *Putorius*, but by way of compromise may write the sub-genus between it and the specific name.

The Minks, *Lutreola*, have thirty-four teeth, four less than the martens. They are larger than a weasel, stouter, tail bushier. The half-webbing of the toes, short ears, and the close-set, bristly, glistening pelage, make them approach the otter in its adaptation to an aquatic mode of life. They are next only to the skunk in the fetid pungency of the odor they emit when caught in a trap, or in any way enraged.

In the American Mink, *Putorius (Lutreola) vison*, the color ranges from a light, dull, yellowish-brown to a rich blackish-brown. The deeper the black the more highly is the fur prized. There is a very dark-colored mink which is sometimes called *P. nigrescens*, the Black Mink. It is almost certain that this and *P. vison* are but one species. They range in length from fifteen to twenty inches, the tail being about half as long. The following vigorous passage by Coues photographs the temper of the animal:—"Its tenacity of life is remarkable. It lives for many hours—in cases I have known, for more than a day and a night—under the pressure of a heavy log sufficient to hold it like a vice, and when the middle of the body was pressed perfectly flat the animal showed good fight on our approach. When caught in a trap it gnaws and lacerates itself in a manner painful to witness, even breaking its teeth against the iron. One who has not taken a mink in a steel-trap can scarcely form an idea of the terrible expression the animal's face assumes as the captor approaches. It has always struck me as the most nearly diabolical of anything in animal physiognomy. A sullen stare from the crouched, motionless form gives way to a new look of surprise and fear, accompanied with the most violent contortions of the body, with renewed champing of the iron, till breathless, with heaving flanks and open mouth dribbling saliva, the animal settles again, and watches with a look of concentrated hatred, mingled with impotent rage and frightful despair. The countenance of the mink, its broad, low head, short ears, small eyes, piggish snout, and formidable teeth, is always expressive of the lower and more brutal passions, all of which are intensified at such times. As may well be supposed, the creature must not be incautiously dealt with when in such a frame of mind."

The aquatic habits of the mink make it a good fisher, and in fact modify its diet. It is probably our only species which feeds habitually upon reptiles, fish, mollusks, and crustaceans,—especially upon frogs, fresh-water bivalves, crayfish, and the like. It has been known to attack and kill the muskrat, probably for food. The animal can be tamed and made a pet. Such, however, would not be without danger. Cat-

like, it loves to be stroked and fondled, but its temper is too quick and capricious. The American mink ruts in February, and litters in April in the hollow of a log, or its accustomed burrow; generally the litter numbers five or six. In domestication it has been known to reach ten. Gestation lasts about six weeks, and they litter but once a year. "The young are born blind, their eyes not opening for five weeks. When just born, they are light-colored, hairless, and about the size and shape of a little finger. By the time the eyes are open, they are covered with a beautiful coat of glossy hair."

Dr. Coues gives an interesting account of a minkery, or establishment for breeding minks for sale as ratters. "These tame minks make excellent ratters, hunt vigorously, and soon exterminate the pests. Rats will make off on scenting them; they are so bewildered in flight that they give no battle, but yield at once, and the mink



FIG. 185. — *Putorius lutreola*, mink.

severs the main vessels of the neck so quickly and skilfully that an observer would scarcely imagine the deed had been done."

The European Mink, *Putorius (Lutreola) lutreola*, is a little smaller than the American species, and while the latter has a blackish upper lip, the former is normally white. The Siberian Mink, *Putorius (Lutreola) sibiricus*, holds a rather doubtful position. "The color is peculiar—a uniform, clear, rich fulvous or tawny brown, scarcely paler below; the tail throughout, the same; throat and soles of feet, whitish."

Putorius foetidus is the European Ferret, often called Polecat or Fitch, or Foul Mart, in distinction from *Mustelas*, or sweet marts, — the odor in the polecat being so much more disgusting. The meaning of the latter name is probably Polish cat. It is about sixteen inches long, tail five and a half. It is found nearly all over Europe, and in some parts of Asia. The color is a deep, blackish brown, with a tawny cast. It preys indiscriminately on small animals. It makes a wound so small in the side of the neck as to be imperceptible. Among rabbits it is terribly destruc-

tive, seeming to destroy for the pleasure of it, and has been known to leave twenty rabbits dead at one time. Bell narrates that a female polecat was found to have laid up in a side hole, near to her nest, forty frogs and two toads, having 'pithed' them all, that is, pierced the brain with a bite, so that, though retaining vitality, they could not get away. When one gets into a hennery, or among turkeys, the destruction is very great.

Putorius furo is the true Ferret, originally a native of Africa, which has become a permanent albino, a creamy white, with pink eyes. It is much the same in form as the fitch, but a little smaller. It is a tender creature, and to carry it through our climate, and even the winters of Europe, it needs considerable coddling. Except when excited by the opportunity of tasting blood, it is a stupid thing, with not a particle of affection for the hand which feeds it. The female has two broods in the year, of from six to nine. She often devours her offspring as soon as born, in which case she soon litters again. As pets they are worthless, with no attachment, and somewhat treacherous; but as ratters they are valuable. In Europe they are used to catch rabbits in the warrens. They cross readily with the fitch, and are said to have the strain thereby improved and made hardier. We have watched the ferrets and a pair of the Indian mongoos in the same enclosure, in perfect peace, but they seemed to ignore all familiarity.

Besides these may be mentioned the variety *P. evermanni*, the Siberian Polecat, and *P. sarmaticus*, the Spotted Polecat, of eastern Europe, Poland, and Russia.

A remarkable animal, for which Coues feels justified in erecting a new sub-genus, is the American or Black-footed Ferret, which is found west of the Mississippi, and especially where the gophers, or the prairie-dogs, abound. This animal was named *Putorius nigripes*, the Black-footed Polecat, by Audubon and Bachman. It curiously combines some features of both sub-genera, *Gale* and *Putorius* proper, with others peculiar to itself. It is the strict analogue in this country of the European ferret or polecat. The prairie-dog furnishes food largely to the American ferret, which pursues it into its burrow, and in a literal sense "eats it out of house and home," then looks up another burrow for the same object. Those familiar with these facts call this animal the Prairie-dog Hunter. With a smack of the poetical, Coues' pictorial name tells this habit of the black-footed American ferret, *Cynomyonax*, the "king of the prairie-dogs." Still, seemingly unwilling for the present to take it out of *Putorius*, the "king," like other monarchs, is loaded with nomenclature, thus: *Putorius (Cynomyonax) nigripes*; but, in less regal style, he may be simply called the American or black-footed ferret.

One of the sub-genera into which the genus *Putorius* has been cut up is *Gale*, which is the classic word for weasel, although the Greeks made the word also do duty for marten, polecat, and, with a qualifying word, even for ferret. So again we must put up with the inconvenience of a middle name for the sake of its suggestiveness.

The weasel is very small—length of head and body between six and eight inches, of tail about two, not reckoning the hair; legs very short; body almost cylindrical, very attenuated, in fact vermiform. The neck is very long, making the fore-legs appear to be set back too much, and, when the head is raised, giving the little animal a look of pert inquisitiveness. Its range is the northern portions of the United States, and beyond; also Europe and Asia, northerly.

The Little, or Least Weasel, common to both the Old World and the New, is *Putorius (Gale) vulgaris*. Its pelage is a light, reddish-brown above, and white below.

In the winter of high northern latitudes the whole coloration changes, excepting perhaps the end of the tail, all the fur becoming whitish, or pale sulphur. The change is suggestive of that undergone by the ermine.

The common weasel has sometimes been caught and carried off by raptorial birds, the hawks and kites, but sorrow be to the captor in such cases. He has caught a little Tartar; for the little captive has bitten into the side of its enemy, so that both have fallen to the earth, the bird mortally wounded, and the little quondam prey comparatively unhurt. Says a writer: "The weasel's courage in defending itself, when attacked by birds of prey, is universally admitted; nor is it deficient in fierce opposition to dogs, and even men, when its nest is invaded by either. The nest is constructed of dry leaves and herbage, and is generally lodged in some snug locality, as a dry ditch, the hollow of a tree, etc. It produces four or five young at a birth, and generally has two or three litters in a year."



FIG. 186. — *Putorius vulgaris*, weasel, and *P. erminea*, ermine, in summer pelage.

It is probable, from an experiment made by Mr. Bell, that the weasel does not seek encounters with snakes. The same author also disputes the blood-sucking charge, and that of wanton destruction by this animal. It destroys for food, biting through the head into the brain with such expertness that its victim can scarcely utter a cry of pain. The brain seems to be eaten first, then the rest follows. If not hungry, having taken out the brain entirely, it will hide the carcass until needed. In pursuing mice, moles, and rats, it can follow them into their runs or holes. "Its long, flexible body, its extraordinary length of neck, the closeness of its fur, and its extreme agility and quickness of movement," with its keenness of scent, give it every qualification for successful pursuit. Should its prey elude its sight, it will 'nose' the track by scent, and when it loses the scent, like a well-trained dog it will quarter the ground until it is recovered, when it will start afresh, hunting sometimes an animal much larger than itself. Though short-limbed, this lithe little beast has a snaky springiness. It is recorded that in England a weasel surprised a bevy of

partridges, and, as they rose for flight, it sprang and caught one of them when two feet in the air, and had begun eating it ere the observer could get up to secure the bird.

If hungry a weasel's proximity to a poultry yard is far from desirable. But in barns, hay-ricks, grain-stacks, etc., it is decidedly advantageous, as it will surely exterminate or drive away such vermin as rats and mice. Even rabbits, moles, and the wild mice are glad, at a weasel's coming, to give it a wide berth. We know but little of the habits of the weasel in its American haunts; but it is the writer's opinion that the mink often gets the credit of clearing out the vermin from a farm-yard when it has been done by a weasel. Here, as abroad, this little beast sometimes seeks the contiguity of human dwellings, and even enters occasionally the populous town.

The Stoat or Ermine, *Putorius (Gale) erminea*, is found in Europe, Asia, and America, north to the limit of terrestrial mammals. Though not known in the Gulf



FIG. 187. — *Putorius vulgaris*, weasel, and *P. erminea*, ermine, in winter pelage.

States, it is found in America to nearly the southern border of the United States, thus meeting in or near Mexico the range of the South American *Putorius*. Its length of body runs from eight to eleven inches. Tail brushy, with a black tip. Its summer dress is a dull mahogany-brown above and pale sulphury-yellow below; in winter in most regions it is pure white all over, except the black end of the tail. The Ermines of Europe, Asia, and America are specifically the same.

Notwithstanding that its fur is the emblem of purity, when under the influence of fear, anger, or the sexual passion the ermine can make itself very offensive — emitting a fluid whose odor, though not so lasting, is nearly as pungent as that of the skunk. Thus it happens that when denuded of its pelt by the trapper, the Indian, who eats all sorts of nasty things, declines the carcass of the ermine. The female is not so large as the male, but, sex aside, is otherwise identical. "She makes her home in an underground burrow, beneath the stump of a tree, under a pile of rocks, in a decaying log, etc., and brings forth a large litter. The number is very variable — four or

five is probably the average." It is asserted that as high a number as twelve has occurred. The litter comes from March to June, according to latitude; ordinarily it is in April or May. In northern latitudes the little ones may come before their mother gets on her summer dress. Pallas says he captured two young of a white mother early in May in the hollow of a tree. "The cavity was separated into several compartments, arranged with some care. One of these contained a heap of fresh mice and shrews; another a quantity of the rejected skins, feet, and tails of these animals. The nest was extremely foul." The cry of the young, says Pallas, was like that of a newly-born kitten. "At the age of ten or twelve days the little animals were ashy above and white beneath. The mother, courageous in defence of her offspring, could scarcely be driven away, and followed the captor of her brood for a long time."

The ermine is solitary, doing its thorough work alone—for wherever it makes its home the rats and mice must go; and, indeed, all small animals within reach—even the poultry, when its proper prey fails. It is without doubt true that when the opportunity offers it makes large destruction, for the sheer savage glee of carnage. Audubon says: "We once placed a half-domesticated ermine in an outhouse infested with rats, shutting up the holes on the outside to prevent their escape. The little animal soon commenced its work of destruction. The squeaking of the rats was heard throughout the day. In the evening it came out licking its mouth, and seemed like a hound after a long chase, much fatigued. A board of the floor was raised to enable us to ascertain the result of our experiment, and an immense number of rats were observed, which, although they had been killed in different parts of the building, had been dragged together, forming a compact heap." In like manner the ermine can be utilized for rabbit hunting.

The singular change of coat, from the stoat's mahogany-brown of summer to the pure white ermine of winter, has elicited considerable controversy as to the cause. Some rather ingenious notions have been ventured. After all, the fact is a simple one. This phenomenon does not occur where the animal knows no winter, and the higher the latitude the more perfect and complete the change; in a word, both colorations are seasonal changes. The brown pelage comes on with the summer, and the white one with the winter. And all this for a beneficent purpose. While in the sunshine a dark dress will absorb heat, but it will also radiate the internal heat. Besides, the animal is but little in the sunlight. Now while a white dress absorbs from the sun but little heat, it radiates but little, hence is a conservator of the internal stock of warmth. Besides, the white fur affords concealment in the snow.

Of the ermine, Audubon speaks in glowing words of admiration. He shows, and truly, that it is the farmer's friend. "Graceful in form, rapid in his movements, and of untiring industry, he is withal a brave and fearless little fellow." Aye, verily; but after the manner of Coues, what shall be said? He assails his prey not only on the ground, but under it, and on trees, and in the water. Swift and sure-footed, he makes open chase, and runs down his prey; keen of scent, he tracks them, and makes the fatal spring upon them unawares; little and of extraordinary slenderness of body, he follows the smaller through the intricacies of their hidden abodes, and kills them in their homes. He seems to kill instinctively for the simple love of taking life, in gratification of superlative blood-thirstiness. Which one of the larger animals will defend itself or its young at such enormous odds? A glance at the physiognomy of the weasels would suffice to betray their character. The teeth are almost of the highest known raptorial character; the jaws are worked by enormous masses of muscles cov-

ering all the side of the skull. The forehead is low, and the nose is sharp; the eyes are small, penetrating, cunning, and glitter with an angry, green light. There is something peculiar in the way that this fierce face surmounts a body extraordinarily wiry, lithe, and muscular. It ends a remarkable long and slender neck in such a way that it may be held at right angle with the axis of the latter. When the creature is glancing around, with the neck stretched up, and the flat, triangular head bent forward, swaying from one side to the other, we catch the likeness in a moment—the stoat is the image of a serpent.

We can now do no more than mention the Bridled Weasel, with its fearful string of names, *Putorius (Gale) brasiliensis frenatus*, found on the Pacific slope from California to Ecuador; and the Long-tailed Weasel, *Putorius longicauda*, the same size as the ermine, and found in the region of the upper Missouri and its tributaries, and probably west to the Pacific.

With the Martens we shall close our large group Arctoidea. We deal now with the genus *Mustela*. In it are included the martens and the sables, “inhabiting the northern portions of both Old and New Worlds, and particularly abundant in the higher latitudes.” “The pelage is soft and long, but not shaggy; whole-colored, or nearly so, never whitening in winter. Progression digitigrade; habits not aquatic.” “The species have a somewhat fox-like or cat-like superficial aspect, rather than that appearance we usually associate with the name of ‘weasel,’ being much stouter-bodied, more copiously haired, and bushier-tailed; one species, indeed, is commonly called black ‘fox,’ or black ‘cat.’ Though destructive to small mammals and birds, they are less ferocious and bloodthirsty than the weasels, whose sanguinary impulses seem insatiable; and at times they show a playful and comparatively amiable disposition.”

It is from the *Mustela* proper that the sable fur is obtained. The words marten and sable are so often used interchangeably that any attempt to state a difference might confuse; we prefer to make no distinction. “All sables are martens.” With the different ‘martens’ and ‘sables’ of the furrier, distinctions simply based on slight shades of color, the capricious canons of imperious fashion, we have nothing to do.

We will introduce our North American species first, of which there are two. *Mustela pennanti* is variously known as Pennants, Marten, the Pekan, the Fisher, Black Fox, Black Cat. It is the largest of the genus, and stout; length of body from two to three feet, and the tail over a foot. Its pelage is black, or blackish, generally darker below. It has a dog-like cast of countenance, “though the apparent obliquity of its eyes gives it a sinister look.” Its range is in woody regions of North America in latitude between 35° and 65°. “In size, as in some other points of form, vigor, and ferocity, it approaches the wolverine, and is obviously the connecting link between *Mustela* and *Gulo*. It has no immediate representative in the Old World.” The word pekan is obscure, and the name fisher is misleading. It explains nothing to say, “it is fond of stealing fish,” etc. This is true of all the family when a chance offers. But, unlike some of its cousins, the pekan has never been known to fish for itself. Says Sir John Richardson: “The pekan is larger and stronger than any variety of the pine marten, but it has similar manners; climbing trees with facility, and preying principally upon mice. It lives in the woods, preferring damp places in the vicinity of water; in which respect it differs from the marten, which is generally found in the dryest spots of the pine forests. The fisher is said to prey much upon frogs in the summer season; but I have been informed that its favorite food is the Canada porcu-

pine, which it kills by biting on the belly. It does not seek its food in the water, although, like the pine marten, it will feed upon the hoards of frozen fish laid up by the residents." As confirming this porcupine statement, it is quite enough to say that Dr. Gilpin alleges that porcupine quills have been found in the pekan's stomach. When flesh food fails it will take to beech-nuts.

The pekan seems to select for a breeding-place a hole high up in a tree, the higher the better, producing from two to four young. It would even seem to prey upon its own close cousins; for the fisher and the pine marten have both been shot in the same tree, the former being in hot pursuit of the latter. It has even been known to give desperate and persistent battle to a raccoon, finally bringing the latter to grief. It also vexes the trappers, keeping up for long distances, even miles, a nightly watch on the traps, and stealing the captured game; and such is its cunning that it will take with impunity the bait from the trap set for itself. Indeed, it tries the trapper's wits to capture the pekan.

The American Sable, or Pine Marten, *Mustela americana*, "is about the size of a large house cat, though standing much lower on account of the shortness of the legs. The length of the head and body is about a foot and a half, more or less; the tail with the hairs is a foot long or less, very full and bushy, particularly towards the end, the reverse of the tapering, pointed shape which obtains in the pekan." "The pelage is long and extremely soft and full. It consists of three kinds of fur. The first is very soft, short, and wool-like, immediately investing the skin, as may be seen in plucking away both kinds of the longer hairs. The second is soft and kinky, like the first, but very much longer, coming to the general surface of the pelt. The third is the fewer, still longer, glossy hairs, bristly to the roots."

Unlike the true weasels, the pine marten lacks audacity. It shuns civilization, and retires into the woods at its advance. Ross speaks of its periodical disappearance: "It occurs in decades (of years), or thereabouts, with wonderful regularity, and it is quite unknown what becomes of them. They are not found dead. The failure extends throughout the Hudson's Bay Territory at the same time. And there is no tract or region to which they can migrate where we have not posts, or into which our hunters have not penetrated. When they are at their lowest ebb in point of numbers they will scarcely bite at all (at the bait of the traps). Providence appears thus to have implanted some instinct in them by which the total destruction of their race is prevented."

The home of the pine marten is sometimes underground, or among rocks, though by preference in the hollow of a tree, frequently dispossessing a squirrel of its nest by driving off or devouring the rightful occupant. It has not a special predilection for pine woods, as its name would imply. The Coniferæ simply happen in its geographical range. But the pine marten, unlike the pekan, which seeks the dry ranges of the woods, prefers nearness to water. "The sable, unlike the mink and the stoat, is innocent of marauding farm-yards, though it does upon opportunity commit larceny on the caches where in high latitudes the natives store meat and fish. It has barely a trace of the fætor of the polecat, hence, like its European cousin, it deserves to be called the 'sweet marten.' It has not that blind ferocity which loves carnage for its own sake. Though in its class a highly organized carnivore, with the appeasing of hunger its ferocity ends. In confinement the marten becomes in time rather gentle, however untamable it may appear at first; it is sprightly, active, with but little unpleasant odor, and altogether rather agreeable."

The European Pine Marten, the Sweet Marten, *Mustela martes*, is sometimes called the Yellow-breasted Marten. Its range takes in a large portion of northern Europe and Asia, Sweden possessing the finest specimens.

The European Beech Marten, or Stone Marten, *Mustela foina*, has a pure white throat. This animal is not so strictly limited to the forests as is the pine marten, for it takes also to the mountain sides and rocky places, and even ventures into farm-yards.

The Asiatic Sable, *Mustela zibellina*, furnishes the celebrated sable, the most precious of the furs. A single skin of a Russian 'crown' sable, with its natural dark bloomy black, will fetch two hundred dollars. Of such, a muff and boa would be worth not far from two thousand dollars, although sets of inferior quality may be bought for two hundred and fifty dollars. The best skins are obtained in Yakutsk, Kamtschatka, and Russian Lapland. Sable skins are in perfection from November to



FIG. 188. — *Mustela martes*, pine marten.

January. At the beginning of winter the sable hunters assemble in considerable companies, and proceeding along the great rivers in boats, take with them provisions for three or four months. At the place of rendezvous the different parties, each under its own leader, take up their respective quarters, where they make huts of trees, and bank up the snow round them. Near these they lay their snares, and then advancing farther they set more, still building new huts in every quarter, and returning successively to every old one to visit the traps, from which they take the game and skin it. Considering the intense cold, and the depth of a Siberian winter, it is easy to see that many of these poor hunters must succumb to their hardship; hence at what a cost is this luxurious fur obtained.

Here we close, so far as the existing members are concerned, this great, seemingly heterogeneous group, the Arctoidea, with its little, slim, agile weasels, and its big, clumsy bears. And this strange assemblage has shown itself to be a natural group in the affinities of structure binding it together, and connecting every member to and

around the central ursine type. We have found in it dental formulæ with molars of the grindstone pattern, and a digestive apparatus fitted for a mixed diet, and the plantigrade feet. Having reached the top of the series we find that though some of the terms of relationship yet exist, the alliance has become weakened. We have now the sharp, trenchant molar of the highly wrought carnivore, the strong flesh-appetency, and the digitigrade feet of the skilled hunting beast. There is a trending now to a canine affinity. To give completeness to the picture it would need to go back to the fossil ancestry of the Arctoidea. The coon-bears have their fossil relations, so, too, the Ursidæ or typical bears, also the weasel arctoids. They all lived far beyond the historic past; at first in synthetic form, and later in simpler, more specialized, and more distinctly representative forms. The list would be long; but a few, at least, should be mentioned.



FIG. 189. — *Mustela zibellina*, Asiatic sable.

In the eocene times was *Arctocyon*, the grim bear-dog, that Caliban beast with hardly a moiety of brain. In the miocene days there were hyæna alliances of form and nature with forms of animal life looking most pronouncedly to civets, and gluttons, and otters, and weasels, and raccoons. At the same time there was a huge plantigradal beast, *Amphicyon*, as large as a polar bear, whose terrible trenchant molars showed his fierce appetite for flesh. In the pliocene period of earthly time *Hyænarctos* flourished, a grim, composite monster, large as a grizzly, and the ancestral type of the hyæna and the bear. According to one authority this strange beast structurally was "almost exactly half way between the dogs and the bears." In the pleistocene era, besides the fierce *Hyæna spelæus*, the Cave Hyæna, was that ancient grizzly, *Ursus spelæus*, the Cave Bear, and probably the native of nearly the same era was the California Cave Bear, *Arctotherium simus*, literally the snub-nosed bear-beast, with a bulldog build of head and face. With these cave beasts, in Europe certainly, the prehistoric man was contemporary. He was himself a troglodyte, and fought these beasts in order to dispossess them of their dens for himself and family, also for food

and clothing. That was probably a sub-arctic climate, and these beasts, like the long, thick, shaggy-haired tiger of the Alpine snows of Mantchuria and Corea, and the similarly clothed leopard of the high mountains of Japan, were also clad to resist the climate. Not so with the poor, naked, palæolithic man. Armed at best with his weapons of bone and stone, he must protect himself against that *Drepanodon latidens*, the hugest, fiercest carnivore, with side tusks sabre-shaped, saw-edged, and eight inches long, the incomparable savage of the beasts. From sheer necessity also he must possess himself of the cave bear's coat and flesh as game, and his den for a home. Writing of the red man, says the Abbé Domenech, "The hunter who slays a grizzly bear, which is considered the finest and most honorable of all game, has the right to wear the animal's claws as a necklace. This decoration confers the rank of hero in the solitudes of the west." It is highly probable that the ancient cave man was in a like manner distinguished for his prowess, and that he appeared at the council of the troglodytes, the admired hero, ensignied by the claws of a great cave bear which he had slain in open fight.

SAMUEL LOCKWOOD.

SUPER-FAMILY II. — CYNOIDEA.

This super-family contains only one family, the CANIDÆ, and its characteristics are therefore those of that family. The Canidæ exhibits, in its living representatives, a uniformity of structure little less marked than that of the Felidæ, accompanied by less variation in size, so that the greater part of the species are by naturalists included in the single genus *Canis*. Sectorial teeth are present, and are, as in the cats, the last premolar, or false grinder, of the upper jaw, and the first molar of the lower; but the one small tubercular molar of each side of the upper jaw of the cats is replaced in the dogs by two molars of tubercular pattern, while the lower jaw has also two tubercular molars on each side behind the great sectorial. Thus the normal dentition yields the dental formula $i.\frac{3}{3}, c.\frac{1}{1}, pm.\frac{4}{4}, m.\frac{3}{3}, = 42$. The aberrant and singular genus *Otocyon* has an additional molar on each side of both jaws, a peculiarity occasionally shared in by the crab-eating dog (*Thoas*), and a few forms have less than the normal number. Thus the teeth are much less carnivorous in character than those of the cats, and this absence of carnivorous specialization becomes more evident when we look at the canine limbs, which are longer and more free from the body than those of the Felidæ, so that all the dog-tribe walk erect upon their limbs, and are adapted for running rather than for climbing and springing. The toes are, as a rule, five upon the fore, and four upon the hinder feet, with the rudiment of a fifth metatarsal. The extent of the development of this fifth hind toe varies considerably in the group. The toes are terminated by exposed claws that have not the slightest power of retraction, and consequently become blunt and worn at the tips. The inner toe of the fore-feet is placed high up, and in a few cases is lacking; and the clavicles are rudimentary. There are characters of the cranium which show a wide divergence between this family and the Felidæ. The most recent and most thorough study of the characters of the skull and teeth of the Canidæ is that presented by Professor Huxley to the Zoological Society of London in 1880. To quote his language, "There is a remarkable constancy in the characters of all the organs, down even to the minuter details of the patterns of the crowns of the teeth, accompanied by variations, within comparatively narrow limits, in the form and proportion of the parts. The number of the præ-sacral (cervical, dorsal, and

lumbar) vertebræ always remains the same, and that of the caudal vertebræ varies only within narrow limits. In the skull there is considerable range in the proportion of the jaws to the brain-case, and in the extent to which the temporal ridges, always widely separate in young animals, approach and coalesce into a sagittal crest in the adult." There are various other differences of structure, such as the greater or less backward extension of the nasal bones, modifications in the form of the cæcum, and the presence or absence of caudal scent glands, but Professor Huxley shows that dogs that differ in more important points may agree in these, and *vice versa*, so that such characters are of little importance in classification. The skulls and teeth of the Canidæ vary more than any other part of their structure, and as the central region of the base of the skull reaches (in all mammals) its adult condition early, and is the foundation round and upon which the other parts are built, Professor Huxley, taking this part and the shape of the brain-case as his guides, and comparing with each other the skulls of different species, arrives at the conclusion that the Canidæ may be broadly divided into two groups, a truly dog-like or Thoöid, and a wolf-like or Alopecoid series, while the *Otocyon* stands apart from both.

In the thoöid series the frontal bones each contain a hollow or sinus, and the cerebral hemispheres widen out abruptly a little behind their junction with the olfactory lobes. The alopecoids have no frontal sinuses, and the horizontal contour of the brain is that of a pear with the small end forwards. In each of these groups there are differences in the proportional dimensions of the teeth, independently of any variation in number, and these differences give us a series, commencing with forms having small grinding-teeth and sectorials not conspicuously larger than the tooth succeeding them; and ending in forms having large teeth, and sectorials, the upper one of which is about one half longer, and the lower more than twice the length of the grinders next in succession.

In the thoöid group are ranged the wolves, wild dogs, and *Lycaon*, while in the vulpine series the fennec stands beside the foxes. In the higher dogs of both series the crests upon the skull for the attachment of the temporal muscles, wide apart in the young, coalesce into a sagittal crest in the adult; but in the lower types of both, as in the fennec, gray fox, and coast fox of the alopecoid, and in the azara of the thoöid series, these temporal crests remain permanently separate. Moreover the lower forms of both series approach each other and *Otocyon* so closely that Huxley inclines to the opinion that the latter is the nearest living representative of the primitive type of the Canidæ, whence the rest have been derived "by the differentiation of the thoöid from the alopecoid series, and by the occurrence of corresponding series of modifications leading up to the fox on one hand and to the wolf on the other."

One of the most remarkable points in the dental structure of the Canidæ is the resemblance in the sectorial teeth of all the species. The guara of South America (*Canis jubatus*) and the raccoon dog of Japan (*C. procyonoides*), which live largely on fruits and roots, have the same pattern of sectorial that is possessed by the more carnivorous forms. This form of sectorial, and also the patterns of the other teeth, show resemblances to the teeth of the Procyonidæ or raccoon family. The teeth of *Otocyon*, and those of the raccoon and the coati form a descending series; and the form of the lower jaw in *Bassaris* and *Procyon* is similar to that of the ordinary Canidæ.

On the other hand, the dogs present certain characters which point towards the marsupials. The marsupial bones of the latter are the homologues of the fibrous

epipubis found in the former, and in *Thylacinus* are placed in exactly the same relations to the tendons and muscles around them as are their fibrous representatives in the dogs. Another point of resemblance may be found in the form of the lower jaw in *Otocyon* and in the bandicoot, while the four molars of *Otocyon* are a survival of the character of the dentition exhibited by the common ancestors of the Canidæ and the carnivorous marsupials.

The difficulty of classifying the Canidæ is increased by the great range of variation of each species, which is such that, in Professor Huxley's opinion, the examination of a sufficiently large series of skulls and teeth would show a continuous chain, leading



FIG. 190. — *Otocyon lalandii*, otocyon.

by insensible gradations from the least developed to the most developed forms. There is no proof that any species of this family is infertile with any other, and this fact alone shows the near relationship in which the various forms stand.

The *Otocyon*, *Otocyon lalandii*, is the most generalized of living Canidæ, and to some extent links the group to the Procyonidæ. It is a small animal, smaller than the common fox, and well distinguished externally by its large ears, covered with fur, nearly equal to the head in length. In color it is of a uniform gray, except upon the limbs, which are darker, and the tail, which has long black hair. It is a native of southern Africa. In this creature the sectorial teeth are smaller than in any other of the Canidæ, the area between the crests for the temporal muscles is large, and the mandible not unlike that found in the bandicoots. The nasals extend back behind the junction

of the maxillary with the frontal, and the latter bone contains no sinus or cavity. The lateral teeth form a nearly straight line, the outer incisors are smaller than usual in the tribe, and the outer upper ones are separated by an interval from the next pair. The back teeth are $pm.\frac{4}{3}$, $m.\frac{4}{3}$, or $\frac{3}{2}$.

Together with the structural peculiarities already noted, the foxes (*Vulpes*) are distinguished from the dogs and wolves by their bushy tail, elongated pupils, erect acute ears, and long muzzle. The largest skulls of the gray and red foxes are inferior to the average of those of the jackals, and those of the smaller species are less than one half the length of an average wolf skull. The gray and coast foxes have a concealed mane of stiff hairs along the tail, and the mandible is lobate; while the caama and fennec have the temporal ridges little prominent. The teeth are $pm.\frac{4}{3}$, $m.\frac{3}{2}$.



FIG. 191.—*Vulpes cinereo-argentatus*, gray fox.

The Coast Fox, *Vulpes littoralis*, is one of the least of the foxes, as well as, in the lobate form of the mandible, small teeth, relatively small sectorials, and weak jaws, one of the lowest, and nearest to *Otocyon*. It is scarcely more than half the size of the gray fox, and inhabits the northwest parts of North America, and the coast of California, occurring as far south as Honduras and Costa Rica. The tail is about one third of the length of the body, and has a black stripe above, while the fur of the body is black above, and dull cinnamon on the sides. The chin and sides of the muzzle are black. Notwithstanding its usual small size, the largest skulls of this species are quite as near those of the gray fox as they are to those of small examples of their own species, and both Baird and Huxley suggest their identity. The body is stouter than that of a cat, but the limbs are short, slender, and weak, causing it to be a comparatively poor runner.

The well-known species, the Gray Fox (*V. cinereo-argentatus*), shares the characters of the coast fox, but is larger. Its area of distribution extends throughout the United States. It appears that in many localities this fox is becoming far less com-

mon than when the early pioneers invaded the forests, its place being occupied by the more highly developed and evidently more astute red fox.

The gray fox is better adapted than the red for a wooded country, having a certain power of climbing trees not possessed by the latter, and this, conjoined with its lower brain power, has caused it to give way as the forest fell before the woodman's axe, and betake itself to less disturbed localities. The hair is stiff, coarse, and long, of a mixed silver-gray tint, or hoary and black, not unlike the badger, but blacker. On the back, the black predominates, as it does also on the upper surface of the tail. The under parts of the body are pale cinnamon, and the lower surface of the tail chestnut. Entirely concealed by the stiff hair is a soft wavy under-fur. This fox has been found fossil in the bone caves of Carlisle, Pa., and is one of the small-toothed foxes, standing, with the coast fox, lowest among its division.

The Fennec (*V. zerda*), is a pretty little animal, ranging over a large part of Africa, since it inhabits the sandy deserts of Nubia and Kordofan, and occurs along the northern coast and in Senegambia. In color, it is of a very pale fawn, sometimes almost creamy white, and the bushy tail is of the same color, except above its base and at its tip, which are black. It is barely a foot in length without its tail, which is about eight inches long. The eyes are blue, the whiskers long and thick, the ears large and pointed, the snout sharp, and the body slender, so that at first sight it has considerable resemblance to *Otocyon*. It lives in burrows scooped in the light, sandy, soil, and sallies forth at night to hunt its prey.

Tristram says of two which he possessed, "No pet can rival the fennec in grace and interest. Not above half the size of a cat, it has all the wiles and actions of a fox, and when alarmed by the sight of a stranger will run under a chair or into a corner, and vociferously give forth its tiny bark. My little favorites were fed on milk and morsels of meat, but showed great fondness for dates." It is said to be able to climb the date palm for the fruit it covets. Its fur is highly valued by the natives, and is said to be the warmest in Africa.

Another South African form which furnishes a valued fur is the Caama or Asse (*V. caama*). Its food consists in great part of the eggs of ostriches and other birds which lay upon the ground. It is now, owing to the extent to which it has been chased, becoming rare in the southern part of Cape Colony.

The Corsac or Adiva, (*V. corsac*), is a fox not quite so large as the domestic cat. It is a native of Tartary, Siberia, and other parts of central Asia. It is a very handsome animal, so much so, that in the reign of Charles IX. of France the fashionable Parisian ladies kept it as a pet. Col. Prejevalsky states that it is abundant in Thibet, where the common fox is scarce, and is called Karsa by the Mongols. On seeing a man a long way off it instantly disappears, either by flight, or by crouching close to the ground. During the breeding season, which lasts from the end of January to the end of February, its hideous cry, resembling the hooting of an owl, is heard night and morning. It constructs its own burrows, and is taken by means of traps placed at the entrance of the holes. Nearly allied is the Kokree (*V. bengalensis*) or Bengal Dog. These two species and the kit fox of North America may be considered the representatives of the jackals among the thooids.

Other foxes, allied most nearly to *V. vulpes* and *V. fulvus*, are the Sobova or Tahaleb (*V. niloticus*), a native of North Africa and Egypt; *V. adusta*, the Canduc, found in Caffraria and other parts of South Africa; *V. mesomelas*, which ranges from Abyssinia to the Cape, and is known as the Cape Jackal and the Tenlie; *V. flavescens*,

the Persian Fox, occurring also in India; *V. montana*, the Hill Fox of Nepal and Thibet; and *V. japonica* of Japan, a form very similar to the English fox, *V. famelicus*, and *V. cana* from Beloochistan.

The Red Fox, *Vulpes fulvus*, is a species subject to considerable range of variation in the color of the pelage. The typical *fulvus* is reddish yellow over the larger part of the body, with a narrow white line upon the belly; the back becomes grizzly posteriorly, and the back of the ears and tips of most of the hairs of the tail are black. A very common variety, known as the Cross Fox, has a dark band between the shoulders, crossed by another over the shoulders; the muzzle and under parts, with the legs, are black, and the rest of the body fulvous, but the tail blacker than in the true red fox. A third variety is black, with the hairs of much of the back ringed with gray, and is the Silver Fox and Black Fox of authors; while a larger form from Utah has been named *V. macrourus*, or the Long-tailed Fox. The range of the red fox is very wide, extending over the whole of North America northward to the countries inhabited by the Arctic fox, southward to Georgia, and westward beyond the Rocky Mountains, but it does not occur upon the Pacific Coast. This species is nearly related to the common fox of Europe, but differs in its finer fur, brighter color, narrower and more delicate head, sharper muzzle, etc.

The red fox has the same habits of crafty cunning which have rendered the European fox famous in story, as it is a daring and clever robber, and often contrives most artfully to elude the hounds. A story is told of one that at a certain fence corner always mysteriously disappeared from sight and scent of man and dog. At length one of the huntsmen concealed himself at the corner, and observed the fox walk leisurely to a point opposite a leaning tree some twelve feet distant. With a stoop and a bound he cleared the intervening distance, and, alighting on a convenient knot, ran along the tree and hid himself in the hollow of its broken top.

The red fox is equal, if not superior, in size, to the European species, and measures about thirty inches from the nose to the root of the tail, which is nearly a foot and a half in length to the end of the hair.

Where the farmyards are not sufficiently numerous to furnish him with food, the red fox lives on wild fowl of various kinds, upon which it springs while they are asleep, upon crabs and fish when near the seashore, which he frequents in the winter; and upon rats, rabbits, and such other small mammals as he can catch, as well as eggs, and even on crickets or carrion when hard pressed. The female brings forth from four to even seven young, which are covered with a soft, woolly fur of a pale rufous tint.

In the central regions of North America, from the Cascade Mountains of Oregon to the timbered lands of the lower Missouri, occurs the Kit Fox, Swift Fox, or Burrowing Fox (*Vulpes velox*). This is a small species about twenty inches in length, with a tail a foot long. In the basin of the Upper Columbia it is more common than any other species, but does not appear to be found northward of the Saskatchewan. The face is broader and the nose shorter than that of the red fox, while in color it is of a brownish gray, becoming reddish orange on the breast and flanks, and white below. The hairs are ringed with grayish brown, yellowish brown, and black; and the under fur is full and close. The soles of the feet are so densely covered with long, woolly hair that the callosities are hidden, and the ears are very small and thickly coated with hair. In winter the fur is pale grayish-brown. It is a dexterous burrower, and habitually lives in holes in the ground, where the female, in the spring, brings forth from four to eight young.

The Arctic Fox, *V. lagopus*, is one of the most beautiful, and at the same time one of the smallest of the foxes; the fur is silky, bluish or brownish gray in summer, and pure white in winter; the tail is very full and bushy, and the soles of the feet are densely furred. It ranges southward to Labrador and Newfoundland, is found in all the Arctic regions of North America, and also in northern Asia and parts of northern Europe, as well as in Iceland and Spitzbergen. This and the lemming are the only mammals that may be considered aboriginal in Iceland, and even these may possibly have crossed on ice from Greenland. The Icelandic foxes do not, as a rule, become white in winter. The Arctic fox constructs its burrows in groups of twenty or thirty, excavating them in the summer months. Its fur is in considerable request, especially



FIG. 192.—*Vulpes lagopus*, Arctic fox.

the white fur of the winter. In consequence probably of its less intimate knowledge of man, due to its residence in thinly peopled countries, this species is less crafty in avoiding a trap or baffling a hunter than most of its relatives.

The European Fox (*V. vulpes*) is the *Vulpes* of the Romans, the fox that has given the title to its tribe, the cunning Reynard of mediæval story, and the creature the possession of whose "brush" is the only tangible end of the pompous chase with hound and horn that is the delight of the British squire and yeoman. In form and appearance this species closely resembles the red fox, but the color is not so bright as in the red species. The range of the fox includes the whole of Europe, and parts of Asia and Africa. In Asia it occurs in Asia Minor, and spreads thence eastward through the highlands to Thibet and Kansu. The female goes with young from sixty to sixty-five

days. The young are born in April, attain their full growth in about a year and a half, and live at least thirteen or fourteen years.

Besides the characters already given, the thoëid section of the Canidæ has the pupil of the eye circular, and the largest members attain greater dimensions than those of the foxes. South America is the headquarters of the lower thoëids, but in Japan and Northern China the type re-appears in the raccoon dog, which is by some considered a distinct genus. The thoëid series, as it contains the highest members of the family, contains also the greatest number of variations from the usual type — variations which are really slight, yet which have induced some naturalists to frame sub-families



FIG. 193. — *Canis cancrivorus*, malkong, crab-eating dog.

for their reception. The genus *Canis*, the first to be considered, has a formula $pm.\frac{4}{4}, m.\frac{2}{3}$.

Under the name South American Fox Wolves are here grouped the various species of thoëids that, to the exclusion of the alopecoids, occupy South America. These have been described under ten specific names. *C. antarcticus*, which is also found in the southern part of the continent, differs from the rest in the large size of the sectorials as compared with the succeeding teeth, and in these respects is the close analogue of the coyote of North America, which it equals in size. The forms which inhabit Brazil and Guiana, viz., *C. cancrivorus*, *C. fulvipes*, *C. braziliensis*, *C. rudis*, and *C. azaræ* are regarded by Huxley as mere local varieties of the first, although, on the average, the cranium of the last is smaller than that of the others. In *C. rudis*,

which has the largest skull, the approximation to *C. azaræ* is so close that no osteological or dental characters can be found to separate them. The form known as *C. azaræ* has the widest distribution of the South American Canidæ, as it occurs throughout Brazil, and southward to Paraguay and Patagonia. The fore-legs are gray externally, and the soles of the feet blackish brown. *C. vetulus*, also a native of Brazil, has the least modified dentition of any of the group, and in this respect corresponds with *C. littoralis* among the foxes. *C. cancrivorus*, the Maikong or Crab-eating Dog of Guiana, occasionally develops a third molar in the upper jaw, and a fourth (third tubercular) in the lower, thus possessing the dentition usually found in *Otocyon*. The snout of this form is blackish. It hunts in small packs.

Largest and fiercest of the South American species is the Guara (*C. jubatus*), which has a mane, and outwardly presents some resemblance to the hyæna. In color it is yellowish red, with some black upon the jaws, black mingled with red upon the mane, and a white spot under the head. It reaches a length of five feet, and lives a solitary life, not hunting in packs like the wolf. The skull of this species equals in size that of an ordinary prairie wolf, but the teeth are of the same type as those of the smaller South American species, that is, the sectorials are but little developed. The name of Aguara, or Guara, appears to be an imitation of its loud cry, "gou-a-a." It is the Culpeu of the Chilians. In Paraguay it inhabits the lowlands and marshes. In *C. magellanicus*, which only inhabits the southern part of the continent, not ranging northward beyond Chili and Bolivia, the skull is rather larger than in *C. antarcticus*. All of these fox-wolves have long and fox-like tails.

The largest and, on the whole, the fiercest of the Canidæ, the only one of the Old World forms that is formidable to man, is the Wolf, *Canis lupus*, if we include under this name all the varieties that have been described. All the Asiatic thoëids distributed north of the Altai range are mere varieties of the common wolf, while the range of variation exhibited by the skull of the latter includes all the cranial differences presented by these so-called species. Huxley states that the Indian Wolf (*C. pallipes*), or Landgak, approaches the jackal more nearly than any other of the Old World wolves. The range of the wolves extends from the German Ocean to the Pacific, embracing the whole of Europe, and by far the greater part of Asia.

The wolf is now extinct in Great Britain, but in the reign of Henry VI. it still existed in Sherwood Forest, and the last wolf in Scotland was killed in 1680. In Ireland one was killed as late as 1710. King Edgar's tax upon the Welsh of three hundred wolves' heads per annum rooted them out, for the time, in four years, showing a population of about twelve hundred wolves before the slaughter began. That they were not long ago very abundant in France is shown by the publication, in 1768, of a work, addressed to the king, and entitled, "Méthodes et projets pour parvenir à la destruction des loups."

The method of attack employed by wolves upon cattle is to bite their hind-legs so as to hamstring them; while their method of attacking a horse is to spring upon his back, or seize him by the buttocks, taking good care to keep out of range of his heels.

In the Pyrenees a black variety of wolf is found, and is there more common than the ordinary wolf. This variety is said to extend into France, and to the Tagus in Spain. Black wolves also occur in the mountains of Friuli, and about Cattara, and in parts of Russia. The wolves of France are browner and somewhat smaller than those of Germany; the Russian race is longer in the body, and appears heavier from the

abundance of long, coarse hair on the cheeks and throat; while Scandinavian wolves are similar in shape to the Russian, but heavier, and deeper in the shoulder, and lighter in tint. In the winter they are said to become white. On the other hand, the wolves of Italy and southeastern Europe are fulvous. The female produces four or five at a litter. The male hunts for them, bringing them small quadrupeds, and game birds of various kinds, and both parents take them out to teach them to hunt when they are sufficiently grown. The Chanco, Golden, or Tibetan wolf is yellowish white, with much pure white below. It inhabits Chinese Tartary and Thibet, and is said to range over the plains in large packs, and attack the yak, orongo, and other large animals. It is



FIG. 194. — *Canis lupus*, wolf.

more cowardly and less powerful than the gray wolf, and never allows man to approach it by day.

Canis procyonoides, the Tanate or Raccoon Dog of Japan, Amoorland, and probably China, has a short bushy tail, and some other peculiarities, yet is near to the wolves. A female in the London zoological gardens gave birth to six young. *C. hodophylax* is another Japanese form which Huxley believes to be near to the wolves.

The question of the distinctness of the American Wolf from that of the Old World is one upon which much ink has been wasted to little purpose, since the answer can never be more than the personal opinion of the naturalist who gives it, founded upon his idea of what constitutes a species. Certain it is that the geographical varieties of both the European and American wolves differ as widely among themselves as do

the so-called typical forms from each other, and it is now usual to consider them identical.

In color the American wolf varies greatly; on the Upper Missouri there is a pure white variety, lower on the Missouri lives a dusky, lead-colored form; Florida and the Southern States have a black variety; while in Texas a rufous race is found. All these vary in shape as well as color, the southern forms appearing more slender and longer in the legs, perhaps on account of their shorter fur.

The prevailing color, as in Europe, is gray, and this variety extends from the Gulf of Mexico to the Arctic regions, and throughout the entire width of the continent.



FIG. 195. — *Canis latrans*, coyote.

The female brings forth in April from four to nine young, in a burrow. Like its European relative, the American wolf hunts in packs, and though, like its kind, sufficiently cowardly under ordinary circumstances, may become so sharp-set by hunger as to prove dangerous to man. A pack of wolves always follows a herd of bisons, ready to worry to death, and ultimately to feed upon, any individual of the herd that through sickness or exhaustion may be compelled to fall behind the rest. They never dare, however, to attack a healthy adult animal; so that their passage near or through a herd excites no fear, and this is so well known that hunters occasionally wear a cap with two ears, in imitation of a wolf's head, in order to approach nearer to their game.

Wolves are said to destroy many foxes, and one has been known to run down a reindeer. A hungry wolf will, in fact, eat almost anything, and a pack never fails to

devour the bodies of those which are slain in their combats with buffaloes. Spite of all their efforts, in severe seasons the struggle for life is too much for them, and many perish.

Prof. Huxley states that while a large skull of the American form is very like that of *C. lupus*, others have teeth little larger than those of the coyote, in spite of their larger size. In these small-toothed skulls the profile is concave, like that of the mastiff or Newfoundland dog, instead of straight, like that of the greyhound or *C. lupus*. As a rule, the American wolf is smaller than the European one.



FIG. 196. — *Canis dingo*, dingo.

The Coyote, *C. latrans*, as has been well said by Baird, replaces in America the jackal of the Old World. Like the wolf, it hunts in packs, but its smaller size and powers render it far more timid in habit, so that, notwithstanding the evident near relationship established between it and the wolf, it may certainly be regarded as, at the present date, a distinct species. In color it is a dull yellowish gray, clouded with black, while the under fur is of a plumbeous tint, and the under parts dirty white. The coyote ranges over the plains and across the Rocky Mountains to the Pacific coast, where it continues to be abundant even in the immediate neighborhood of large towns. It is seldom seen by day, its crafty and timorous nature preferring the darkness for its depredations, and for the emission of that chorus of dog-like barks which is only too familiar to the lonely dweller in the solitudes of plain or forest. In astuteness the coyote is a match for any other animal, and in a fair fight will kill a rattlesnake by

watchfulness, a feint, and a sudden spring at the throat. There is, according to Huxley, no difference of any importance between the skull of the coyote and that of the domestic dog.

It was at one time thought that the Dingo, *Canis dingo*, the only carnivorous placental mammal found in Australia before the introduction of European species, might possibly be the descendant of the domestic dog run wild, but this is disproved by the fact that its remains have been found in the quaternary strata of that island continent. Still it is possible that he may have been introduced by quaternary man. The



FIG. 197. — *Canis aureus*, jackal.

dingo is rather less than two feet high, and about two and a half feet in length; in color it varies greatly, some examples being to a great extent black, while others are pale brown. When teased it does not bark or growl, but erects its head and becomes furious. Its prowess as a hunter is too well known to the shepherds of Australia from its depredations among their flocks.

The best known of the Jackals is the Asiatic species (*Canis aureus*), which ranges through Hindostan, Ceylon, and other parts of Asia, to the Caspian and the Mediterranean. The African species (*C. anthus*) appears to extend through the greater part of Africa, since it occurs in Senegal and other parts of the western coast, along the whole of North Africa, and southward through Nubia. In Abyssinia *C. simensis*, the Abyssinian Wolf, is found; at first sight it appears to be very different from the jackal, on account of its elongate muzzle and palate, accompanied by premolars of small size and

widely separated. *C. aureus* is, however, very variable in the length of the palate, so much so that the difference between the shortest and the longest palates in a series of skulls of that species was exactly the same as that between the longest and a skull of the Abyssinian wolf. The range of the jackals is extended eastward in Asia by the species of *Cyon*, which, notwithstanding the diminution in number of molars, are considered by Huxley as modified jackals; and southward in Africa by the *Lycaon*, or hunting dog.

In color *C. aureus* varies from yellowish gray to a mixture of gray and black, with tawny shoulders, haunches, and legs. The piercing, peculiar, and unearthly cry of a pack of jackals prowling through the village at night is familiar to all who have lived in Oriental lands, and has a weirdness that is appalling to weak nerves. Like its analogue the coyote, the jackal is an arrant coward, and does not appear to dare attack a human being even when in greatest numbers or most sharply pressed by hunger. It will devour the dead upon the battlefield, and is said to be in the habit of scratching away the earth from graves to feed upon the corpses. Though not the lion's provider, as he is called in old works upon natural history, the jackal is the lion's attendant, feeding upon the carcasses abandoned by the monarch of the desert. The offensive odor of the wild animal is stated to disappear upon domestication.

The Domestic Dog, *Canis familiaris*, in its various aspects, would alone suffice to fill a large volume. The great number and wide range of form and color of the existing breeds; the differing capabilities of these breeds, and their uses to man; their origin, whether by man's selective action in breeding, or by descent from distinct wild breeds; examples of high intelligence exhibited by particular dogs; the history of the dog among different races of men as assistant in the chase, or humble companion and guardian of the household; all these are themes of breadth and interest requiring much space for their full discussion.

The date of the taming of the dog is lost in the dim distance of an antiquity far beyond that of history, and it appears probable that it was a very gradual operation, commencing, it may be, with the simple association of an untamed pack of dogs and a band of savage men in the chase of the game coveted by both; continued by both for the sake of mutual benefits, and ending by the partial subjugation of the less intelligent animal, whose share in the spoils was reduced to that allotted to it by its weapon-carrying coadjutors.

Palæolithic man may have possessed the dog, or at least have been aided by it in the chase, and neolithic man, he of the stone village on the hill, and of the pile-built dwelling on the lake, certainly possessed it, and used it as an aid in keeping his flocks and herds.

That the ancient Egyptians possessed the dog is proved by both representations and remains found in tombs. Anubis, son of Osiris, was represented with the body of a man and the head of a dog. Cynopolis, the dog city, was built in his honor. The Greeks had several breeds of dogs. The favorite dog of Alcibiades, as represented in sculpture, was much like a Newfoundland. Alexander had a bulldog, or, perhaps, a Molossian dog, that dared to seize upon a lion. The Greeks had no swift stag or foxhounds, and did their hunting with beagles. The dogs of Rome were classed as *pugnaces*, *sagaces* and *celeres*, fighters, wise and swift. The latter appear not to have been known in early Greece and Rome, but to have spread southward from the western and northern parts of Europe, probably from Celtic lands. The *sagaces* were said to have come from Greece, the *pugnaces* from Asia.

This intermixture of several natural species in the formation of the various breeds of tame dogs that are the servants of mankind, civilized and uncivilized, is indisputable. It is a known fact that not only do the Indian dogs breed with the coyote, but that the offspring is fertile. It is usually considered that the European wolf is the source from which many of the varieties commonly maintained by civilized nations have mainly descended, but it appears to be the opinion of Fitzinger, who has devoted much research to the question, that our principal breeds are descended from species of dogs that now no longer exist in a wild state. He states that in the Greek and Roman records fourteen kinds of dogs can be distinguished, five of which were entitled to rank as species, and five as climatic varieties, while the rest were either hybrids or artificially-produced breeds. The Egyptians, according to the same authority, had seven kinds of dogs, three of which were distinct species. He admits, however, that the interbreeding of the wolf, jackal, and even the fox, with the originally tamed species influenced certain breeds; and concludes that among our domestic dogs seven species are included: *C. domesticus*; *C. extrarius*, or the spaniel and Newfoundland dogs; *C. vertragus*, the badger dog; *C. sagax*, the hound; *C. molossus*, the bulldog; *C. leporarius*, the greyhound, and *C. caribæus*, the naked dog.

Savage and partially civilized peoples have tamed the wolves or wild dogs of the country they lived in. When such tribes have migrated they have carried with them their breed of dogs, and in this manner varieties have been introduced into countries where they were before unknown. Civilized nations have acquired many breeds by direct importation, while there can be no question that many have arisen by the intercrossing of varieties, and also by the interference and artificial selection of man himself, who has always been upon the watch to perpetuate and exaggerate points that might prove useful to him. The dogs of savage tribes are at the present time little more than half-tamed wolves, and such were probably the dogs that assisted in the chase our ancestors of the bronze age. The Eskimo dog, used as a draught animal, pulling sledges with their freight, living or dead, over the rough ice inside the Arctic circle, are a case in point. In the form of their bodies, their short pricked ears, their thick furry coat, and bushy tail, they greatly resemble the wolf of the same regions, the resemblance being closest in those that are of a light color. The greatest difference is in the upcurled tail, which appears to characterize all dogs subject to man's dominion.

Some Eskimo dogs are dingy white, with a tinge of yellow, others blackish; all have hair three or four inches long, and a thick under coat of wool. They do not bark, but have a long, melancholy howl, like that of the wolf. These dogs are not only harnessed to sledges, but are trained to hunt the polar bear, which they do by engaging Bruin's attention, while they contrive to elude his grasp. Two of them, thus protecting each other, and alternately attacking and retreating, will delay the bear until the hunters arrive with their lances. In a team of sledge-dogs the best is chosen as leader, and is driven by the voice of the driver in much the same manner as horses are.

The dogs belonging to the negroes of central Africa are miserable parasites, but are much prized by their owners. It is a singular fact, noted by Sir Samuel Baker, that there is no trace of the original stock among the wild animals of the country. The domesticated dogs of the Dukhun belong to breeds unknown in Europe; the largest and strongest, the Brinjaree dog, somewhat resembles the Persian greyhound. The Pariah dog, the very name of which has come to be synonymous with outcast, infests every

town and village in India; half-wild, half-starved, belonging to no one, but subsisting by scavenging and petty theft. The dog is not prized in Oriental countries as it is among western nations—it performs the same work with the vultures, is regarded as unclean, and its name is the most contemptuous of epithets. That it was so among the ancient Israelites is evident from many passages in the Old Testament; “to be cast to the dogs,” though similar in form to our common saying, “gone to the dogs,” had then, as it still may have in the East, a terribly literal meaning. “Him that dieth in the city shall the dogs eat” is a curse pronounced three times in the First Book of Kings.

The varieties of dogs differ much in the quality of their hair, and the same breed has invariably the same kind of hair. Thus the greyhound, black and tan terrier, and one kind of spaniel have straight hair, as have also the huge deer-hound, the small Italian greyhound, and the toy terrier; the Thibet greyhound has soft, silky hair, as has also another breed of spaniel; the poodle has curly hair; rough, wiry hair characterizes the wiry terrier and the Irish greyhound; and there are hairless breeds of dogs, the naked greyhound, naked terrier, and naked spaniel. Humboldt describes a naked dog in Peru, and Clavigero figures the Xoloitzcuintli, a hairless dog said to be wild but which from its very name, as Xolotl signifies servant or slave, must, as Belt points out, have been a domestic breed. Tschudi describes two kinds of hairless South American dogs, *C. carabicus*, which has no hair and does not bark, and *C. ingæ*, the common hairless dog, which barks, and has pointed nose and ears. These hairless breeds existed in Peru and Mexico when the Spaniards landed, and exist now, unmingled with the hairy breeds, a fact which proves that they do not interbreed with the latter, or that sterility results. This perpetuation of a hairless skin is cited by Mr. Belt as evidence that the breed arose by natural selection, and not by man’s interference. The Techichi eaten by the Mexicans were probably the young of this breed, as *chichi* is the Aztec verb “to suck.” The Spaniards reported the flesh to be very tender and delicate.

Some breeds of dogs are by many regarded as abnormalities or monstrosities, as the bulldog, pug dog, and Japanese pug, which have the bones of the muzzle defective; the turnspit, again, is remarkable for its short legs. In the Japanese pug the characters of degradation are so extensive and so numerous that, were the breed wild, it would unhesitatingly be placed in a distinct genus, and Cope has described it as such under the name of *Dysodes pravus*. The teeth of this pug differ from those of ordinary dogs in the constant absence of the first inferior premolar and of the last inferior true molar, the false grinders ranging in various individuals from four above and three below on each side to two above and two below, while the molars are either one above and two below, or two above and one below. The incisors, which at birth are normal, are shed at the age of six months, the last tubercular molar of the upper jaw disappears with age, and the first superior premolar is rarely present, and doubtless shed before maturity. Thus an old dog has often only the following teeth: $i.\frac{3}{0}$, $c.\frac{1}{1}$, $p.m.\frac{1}{2}$, $m.\frac{1}{2} = 16$.

The hair of this variety is long and not curled, the color usually black and white, and the size that of a rather small black and tan terrier. Many examples of this singular dog have been brought to this country, and it has recently become fashionable in England to possess one of these pets, which even in Japan are said to be uncommon and expensive. Cope says of it: “It does not appear to possess the senses of sight and smell in the same degree as the species of *Canis*. It cannot follow its master through

a crowded street, and is readily lost, even on open ground where opportunities for sight are good. As house-dogs they are cleanly, and intelligent in certain directions." They do not learn tricks easily, but seem to understand their master's disposition and wishes; are vivacious, and are not disinclined to bite those they do not like. The very large eyes, excessively short muzzle, and inflated forehead give this dog a look of intelligence which its habits do not bear out — it has, in fact, been degraded by an artificial life and fed upon vegetable food until it has almost ceased to be a carnivore.

Leaving the dogs of uncivilized tribes, and such curious forms as the hairless dog and Japanese pug, the ordinary domestic breeds claim a short notice.

The merits of the Shepherd Dog, the most intelligent, probably, of all the breeds of dogs, notwithstanding his bucolic surroundings, have been said and sung so many times and in such varied fashions by bards and natural history writers, that it is hard to say a word that is not known to all. He is the shepherd's friend and companion, the guardian of the sheep from wolves and other foes, and their conductor to and from the pasturage. It is even stated that, on one occasion at least, a shepherd's dog proved himself an able shepherd. In a remote corner of Texas there lived a lonely pioneer, with a considerable band of sheep, which our collie every morning aided to drive to pasture. The man sickened and finally died. In the morning the dog came for him, whined and sniffed at the door of the cabin, but no one opened. Remembering his duty, the faithful creature drove the sheep to pasture, tended them, and drove them back at eve. This he did morning and evening regularly for two years, until at length some settlers came into that section, and found the flock, grown to a large one, still under the charge of the collie, who, like man himself, had subsisted upon it while guarding it, as was evident from the bones scattered around. Apparently, every time he needed food, he had seized the last of the flock to enter the corral, killed it, and eaten it as he required. The slaughter, however, was more than made up by the natural increase of the band.

The Wolf Dog, or Irish Greyhound, is a very large breed, in ancient times common in Ireland, where, according to Pennant's belief, it was introduced by the Danes, who used it to chase wolves. The largest of several, according to Bingley, measured five feet one inch in length to tip of tail, and two feet four and a half inches in height. It is now exceedingly rare. The graceful, slim, swift greyhound was in higher repute in ancient times than he is now. Canute enacted that no person below the rank of a gentleman should keep one. It was an ancient Welsh saying that "a gentleman may be known by his hawk, his horse, and his greyhound." An old rhyme, quoted by Bingley, gives the following as the 'points' of a fine animal: —

"Headed like a snake,
Necked like a drake,
Backed like a beam,
Sided like a bream,
Tailed like a rat,
And footed like a cat."

A good greyhound has been known to run four miles in twelve minutes. The Italian Greyhound is a diminutive edition of its nobler namesake, and has been, and still is to some extent, a favorite pet for ladies.

The Spaniel, or Hispaniolus, is so called because introduced into England from Spain. It is one of the most intelligent of the breeds of dogs, and, thanks to its curly tail and long, drooping ears, one of the most handsome. The King Charles Spaniel,

smaller and curlier than the true, holds its own as a pet dog against all others, and is the saucy, noisy occupant of many a parlor. The Setter, so called from its habit, when properly educated, of crouching when it perceives game, is not unlike the spaniel in appearance, and is also known as the English Spaniel. Though not a swift courser, it is a persevering one, and has been known to hunt the whole day, running in all sixty miles.

The race of large dogs known as Mastiffs is found, under various names, from Thibet to England. One noble variety is the Thibet Dog, one of which is the faithful guardian of every house in Thibet the owners of which are rich enough to possess one. It is also common in Bhotan, and guards the Bhotanese women while



FIG. 198. — Italian greyhound.

their husbands are away on their journeys to the lowlands to sell musk and other products.

The Mastin of Spain and the Matin of France are close to the English mastiff, and all are powerful, thick-set dogs, with strong legs, well-developed jaws, and pendulous lips, able to account for any transgressor upon the premises they protect. The mastiff always barks before he bites. This breed is probably descended from, or at least is nearly allied to, the large and powerful dogs for which the district of Epirus, known as Molossia, was famous. Britain was noted for its mastiffs in Roman times, for the conquerors appointed an officer whose business it was to breed these dogs, and send the best to Rome to be pitted against wild beasts in the amphitheatre. The Gauls trained these dogs to assist them in war. The old story of the three mastiffs which, before King James I., were pitted against a lion, who killed two, but was finally finished by the third, is too well known to need more than mention.

Other Molossian dogs are the old British Bloodhound, the St. Bernard, and the bulldog. The first is, or rather was, for the breed, in a pure state, appears to be almost or quite extinct, one of the largest of canines, since an adult stood twenty-eight inches high at the shoulders. The breed has diminished since its employment, the horrible one of tracking and capturing offenders against the ruling powers, came to an end. Bingley mentions its employment in England as late as 1803 to chase sheep-stealers. Still later it was used in Jamaica to discover the haunts of the Maroons, so as to frustrate their projected descent upon the whites. It was by the aid of these powerful animals that the Spaniards hunted and caught the refractory Indians who would not



FIG. 199. — Water spaniel.

tamely submit; and escaping slaves were, up to a recent period, chased and caught in this country by bloodhounds. Far nobler is the employment of the St. Bernard, named from those kept by the monks of the St. Bernard Pass to rescue travellers lost or overwhelmed in the alpine snows. The pure St. Bernard is far from common, but crosses with other breeds are of frequent occurrence.

The Bulldog is much smaller than the mastiff, but exhibits in a far greater degree, compared to its size, the qualities of strength and ferocity, while it lacks entirely the magnanimity and gentleness of its larger relation. Morose and capable of but little affection, it is essentially a fighting animal, ready at but slight provocation to bite a friend, and showing none of that forbearance towards children and weaker animals that is exhibited by the Newfoundland, St. Bernard, or mastiff. In the last century,

and the days preceding it, this dog was employed in the cruel sport of bull-baiting, for which its carelessness of punishment and tenacious bite eminently fitted it. It always seized its victim in front, holding on to the lip, tongue, or eyes. At present it is not of very common occurrence, and its associations are with the lowest characters. Notwithstanding the extreme shortness and width of the muzzle, the bulldog does not present any of that deficiency of teeth which characterizes the Japanese pug, and the same is true of the undersized, deformed-looking creature which is called the Pug, and which appears to be petted on account of its ugliness.

The Staghound is the largest of the hound group, nearly equalling the wolf dog in size, since its height at the shoulder is about twenty-seven inches. As the wolf-dog became rare in Britain after the extirpation of the wolf, so the staghound became rare with the rarity of stags.

The smaller hound, the Foxhound, has been developed by strict attention to breeding until it fulfils every condition requisite for the chase of the swift and artful fox, — a chase dear to the British yeoman, and in a milder manner to the American farmer also. A foxhound, to be of perfect form, should, says Bingley, have the legs straight, and the feet round and not too large. The shoulders should lie back, the breast be rather wide than narrow, the chest deep, the back broad, the neck thin, the head small, and the tail thick and bushy. Gay indeed is the appearance of the troop of red-coated gentlemen, mounted on spirited horses; of the huntsman and his trained pack, at the 'meet,' at some picturesque spot, early on a bright spring morn; and exhilarating, doubtless, is the chase itself, yet the whole sport is cruelty refined, and a higher state of civilization will put an end to it. Whole books have been written about the foxhound, its points, its habits, its diseases, for the employment of them is one of the chief businesses of the British gentleman. The construction and arrangement of the kennels of a mansion is, in that fox-hunting land, secondary only to that of the stables. Forty couple are, according to Bingley, a sufficient pack, and twenty-five of these are sufficient to take into the field at once, as too many do mischief. The height of this breed at the shoulder is from twenty to twenty-two inches.

The Harrier, or Harehound, is considerable smaller than the foxhound, not exceeding sixteen to eighteen inches in height. It is now used in Britain in the chase of the hare, for which purpose it has superseded the still smaller beagle. The Beagle does not measure more than twelve to fourteen inches in height, and is the smallest of the dogs of chase, so small that a whole pack can be carried to the field in a pair of large panniers. In former times this breed was employed in the chase of the hare, which it captured not so much by speed, for the beagle is a slow animal, as by the exercise of extraordinary perseverance and exquisite scent. Their note while coursing is peculiarly sweet and musical. In old times the hunters used to follow the beagles on foot, carrying a long pole, by the aid of which they leaped over fences and ditches.

The Pointer is *par excellence* the sportsman's dog, and has been trained through so many ages to 'point' when it perceives the game, that the young exhibit a tendency to do so. It was probably introduced into Britain from Spain, and Youatt believes that it is descended from the hound. The Lurcher is by Bingley said to be near the terrier, but Bell speaks of it as a cross between the greyhound and the shepherd dog. It is pre-eminently the poacher's dog, and its stealthy movements and noiseless mode of chasing and retrieving fit it admirably for the night work of the breakers of the game-laws. The *Terrarius*, Terrier, or Tarrier as it is very often pronounced, is so called because of its capability for following the burrowing carnivores of the weasel

and allied tribes into their earths or burrows. The terrier is a sharp and snappish, wiry-muscled and wiry-coated little animal, possessed of great courage, and, though not a rapid runner, capable of long-continued exertion. Its prowess in the destruction of rats exceeds by far that of any cat, since it has learned to kill one after the other with rapid snaps, instead of merely slaughtering for food. The tiny Toy Terrier often occupies a good seat in the drawing-room, or nestles on the lap of its owner, ever ready to salute a visitor with a series of noisy, short barks.

The Newfoundland Dog is said by Low to be probably descended from the native wolf-dogs of Labrador, crossed with some larger breed from Europe. It is the com-

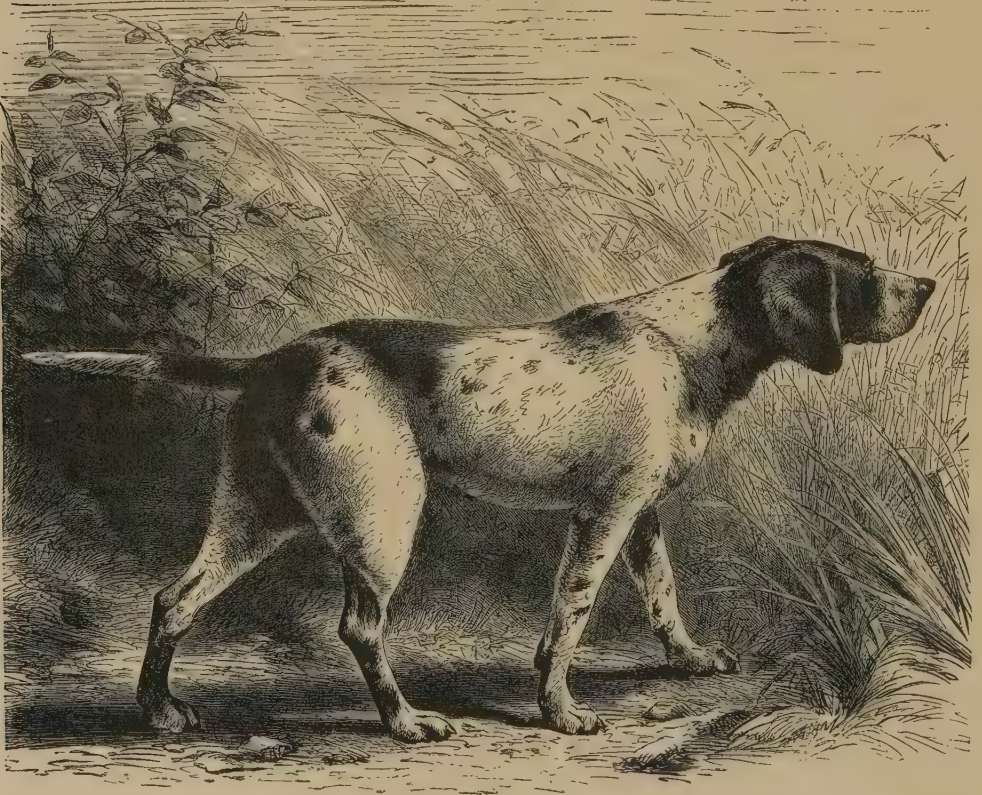


FIG. 200. — Pointer.

mon dog of Newfoundland, where it is put to a variety of uses, and has of late years become abundant both in this country and in Britain. It is a general favorite on account of its great docility and intelligence. As a water-dog it has few superiors, and its strength has on many occasions enabled it to save human beings from drowning.

Other breeds of dogs are the Turnspit, a peculiar breed with a long body and crooked legs, once used to turn the spit upon which meat was roasting; the Water-dog, a long-haired breed in great repute among gunners who live by shooting water-fowl; the black-spotted, important-looking, but not particularly intelligent Dalmatian, or Coach-dog, so often kept for show by rich owners of carriages and by keepers of livery stables; and the Cur, which of all dogs is that which has the worst name, a name

Lycodon venaticus, hunting-dog.



that has come to infer all that is ignoble and mean, and is applied to low-bred dogs and people alike, though it properly signifies a cross between a sheep-dog and a terrier.

An extra molar sometimes appears in domestic dogs, and is regarded by Huxley as a reversion to the earlier and more complete dentition of the primitive canine stock. The period of gestation of the dog is sixty-three days, or precisely the same as that of the wolf.

The Hunting Dog, *Lycaon venaticus*, most unmistakably canine in every part of its structure, has yet, from some peculiarities in its appearance, gained the name of Hyena Dog, and the reputation of belonging to a type intermediate between the dog and the



FIG. 201. — Newfoundland.

hyena. The dentition is that usual in the tribe. The breadth of the upper jaw and the convexity of the facial outlines reminds one of *Cyon*, but the animal is larger, has a short, broad, swollen nose and a short, broad palate, and its teeth are very strong and wolf-like. The very large ears, almost filled by a tuft of white hair, and the long, bushy hair upon the tail, give this creature an uncanine appearance, and the absence of the front inner toe appears at first sight to be a hyenine character.

In color the hunting-dog is reddish or yellowish brown, blotched with large black and white patches. The tail is grayish white, except near its insertion, where it inclines to black. The hunting dog hunts in packs, chiefly at night; is swift, fierce, active, and bold, compared with either wolf or hyena, to both of which it is inferior in size. It is a native of South Africa, and it is common in Cape Colony, where it is detested for its

nocturnal attacks upon domesticated animals. Not only does it kill sheep, but so injures oxen and horses by its stealthy and sudden attacks that they not unfrequently die from the wounds.

The Dhole (*Cyon dukhuensis*) of the Deccan and neighboring parts of Hindostan; the Buansuah (*C. primævus*) of Nepal, Cashmere, and northern India generally; the Wild Dog of Siberia (*C. alpinus*), and that of Sumatra and Malacca (*C. sumatrensis*) have been by most naturalists considered distinct species, and have been formed into the genus *Cyon* on account of the constant absence of the second lower tubercular molar. Huxley considers their affinity to be very close, and as their habits are similar, they may be treated as one species. He remarks that the distribution of this group over an area of nearly sixty degrees of latitude and about as much of longitude in Eastern and Southern Asia, is remarkable when taken in conjunction with the fact that, except in Hindostan the jackals are absent over the same area; while *Cyon* is absent from all that vast area inhabited by the jackals, Hindostan excepted.

The species of wild dogs included in this genus are, according to Prof. Huxley, "nothing but large and slightly modified forms of the jackal type, which thus seems to have become somewhat specialized at the eastern extremity of its area of distribution."

The dhole and buansuah are shy animals, living in jungles and thick coverts far from the haunts of human beings, and hunting in packs after the manner of other wild dogs. Their quarry consists not only of the large herbivores of the region, none of which, except the elephant and rhinoceros, are able to withstand the assault of a pack of these bloodthirsty dogs, but occasionally even the royal tiger himself, who is constrained to flee before their united attack, and, though in the contest he strikes down half of them, is forced at last to yield himself a victim. The dhole is said to chase almost in silence, uttering only a low whimper, like that of a dog that has lost its master, but the buansuah barks with a sound quite distinct from that of dog, wolf, or fox. The dhole hunts in packs of fifty or sixty, but the buansuah is said to limit its numbers to from eight to twelve. The latter animal is sometimes taken young, and utilized as an assistant in the chase, especially that of the wild boar, where its wolf-like sudden snap tells more than the bite of a hound. The dhole is of a rich bay tint, darker upon ears, muzzle, and tip of tail. In size it equals a small greyhound, and none of the group approach in size the wolves of the Old World.

Icticyon venaticus is one of the most aberrant of the canine group, having a dentition differing more widely from that of the rest of the family than any other known species, recent or extinct, except *Otocyon*, and modified in some respects in the opposite direction to the latter. Usually there is but one molar on each side of the upper jaw, and two on each side of the lower. Occasionally an example is found with an extra molar in the upper jaw. The top and sides of the occipital foramen form a tubular prolongation projecting beyond the occipital spine, a peculiarity observed in no other canine. In the large size of the paroccipital and mastoid processes, and in the characters of the base of the skull, it is nearer the dogs, jackals, and wolves of the Old World than to its American relatives, yet so close is it to them that Huxley regards it as only a modification of the type of *C. cancrivorus*, with a reduction of molars carried a step further than in *Cyon*. Other peculiarities are the shortness of the heel, and the absence of the inner posterior cusp of the lower sectorial; also the union of the two halves of the mandible and the smallest of the cæcum. It is a native of Brazil and Guiana. An individual in the gardens of the London zoological society

resembled a young fox, and had the manners of a playful puppy. At its death, when nearly adult, the head and body measured twenty-one inches in length.

Our palæontological knowledge of the Canidæ is as yet imperfect. The European quaternary contains thooids and alopecoids similar to those now existing, and bones of the dingo of Australia have been taken from caves of apparently the same age. A species of *Icticyon* has been described by Cope from caves in Oregon. The explorations of Lund in Brazil show the existence of types similar to those now living in South America, and his *Speothos* seem identical with *Icticyon* or *Cyon*. Another form from these caves, *Palæocyon*, is unique, and more thoroughly carnivorous than any existing species, since, with the normal number of teeth, the sectorials are very large, and the inner cusp of both upper and lower sectorials is obsolete.

Canis borbonides from the pliocene of France has a mandible like that of *C. cancrivorus* (a low thooid); and the fossil fox of Æningen (lower pliocene or upper miocene) is a fox with a slightly different upper sectorial, and a larger pollex than obtains in most Canidæ.

In the phosphorites of France (upper eocene) occur seventeen forms of *Cynodictis* — viverrine dogs, Filhol calls them, as he considers that they shade off into the Viverridæ on the one hand, and toward *Amphicyon* (another eocene canine genus) on the other. Huxley does not consider *Cynodictis* so far removed from the typical Canidæ as *Octocyon*, but as nearer *Icticyon*. *Amphicyon* has the third upper molar, but it is small, and was probably plantigrade and pentadactyle, as we may expect the ancestors of the Canidæ to be. The teeth of some cretaceous mammals (*Arctocyon*, *Hyænodon*, *Pleroderi*) are similar to those of the tenrec (*Centetes*), and those of *Centetes* resemble those of *Octocyon*. This points a way downward through the insectivores to the marsupials.

SUPER-FAMILY III. — ÆLUROIDEA.

This super-family contains the Cats, the Civets, and the Hyenas. Some of the principal characters which distinguish this group from the Cynoidea and Arctoidea are: the 'bulla' or bony shell of the ear is large, smooth, and its cavity usually divided into two chambers; the external passage of the ear is short; the foramen or aperture by which the carotid artery enters the cranium is small; the cæcum is small and simple, and sometimes absent; and the teeth are less tubercular than in the other super-families. There are also several other characters of the skull and of the reproductive organs. Some of these characters may seem unimportant, but there is no doubt that by them is marked off, as well as can be effected by any series of characters susceptible of definition, a group which includes within its limits the most truly carnivorous of the Carnivora, those which feed almost exclusively on animal food obtained by superiority in natural weapons conjoined with swiftness of movement and cunning.

From Mivart we learn that the vertebræ vary in number from thirty-three (in the Manx cat) to sixty (in the binturong), but the usual range is from fifty to fifty-six or seven. The cervical or neck region is largest in the Hyænidæ, variable in the Viverridæ, and in the cats usually equal to about one-fifth of the total length of the spine from occiput to end of sacrum. The greatest absolute length of the dorsal region met with by Mivart among the Æluroidæ was that of a spotted hyena (*Crocota*), in which it measured three feet and one and two-fifths inches. The greatest length of this region noted in the tiger was only three feet two inches.

The usual number of true ribs (united to both spinal column and sternum) is nine, but sometimes eight or ten. The false ribs may be three, four, five, or, in the Hyænidæ, seven. The sacral vertebræ are usually three in number. The sternum in this group is usually formed from seven primary bones, including the manubrium. The number of lobes of the lungs varies also. The spotted hyena has six on the right and three in the left lung, the tiger, leopard, and puma have two in the left lung; but in most species there are four on the right side and three on the left.

All æluroids have three incisors and a canine on each side of each jaw. The outer incisor may be considerably larger than the median ones, as in the Hyænidæ, or slightly so, as in the *Felidæ*. The membrane covering the hard palate is raised into a greater or less number of transverse curved ridges. There is considerable variety in the characters of the stomach of this group. In the genet it is longer compared to its width than in the cat, and in the binturong the length, as well as the curvature of the shorter aspect, are still more exaggerated. In the zinsang (*Prionodon*) the stomach is remarkably large and more globular than is usual.

All æluroids have at least two anal glands, one on each side of the anus, but in the brown hyena there are three pairs, and in *Crossarchus* five pairs.

The Hyenas, forming the family HYÆNIDÆ, are, with one exception, large and powerful animals, usually with jaws of great size and strength, moved by proportionately massive muscles, and armed with formidable teeth, which are, however, less carnivorous in character than those of the cats. These creatures are, together with the vultures, the scavengers of the tropical regions of the Old World, to which they are confined, and are specially adapted, by their entire dental and facial structure, to feed upon the hardest bones, which are crushed between their jaws as rocks are pounded in a crushing-mill, or iron cut by shears. The teeth of the true hyenas are thirty-four in number. The false grinders are conical and very large; the flesh-tooth (last premolar) of the upper jaw has a small tubercle on its inner side; that of the lower jaw has two trenchant points and no tubercle, and there are but two tubercular grinders, one on each side of the upper jaw. The Hyænidæ are digitigrade, the fore-legs are somewhat shorter than is usual in æluroids, the toes are five on the fore-feet and four on the hinder, are straight, and terminate in blunt, exposed claws; the tail is short and bushy, the tongue rough, the eyes large and prominent, and the ears long and acute. The muzzle is narrowed in front, and there is a longitudinal groove along the centre of the under side of the nose. The neck of the Hyænidæ is very long. Mivart found that the cervical vertebræ of a spotted hyena reached two feet in length — dimensions exceeded only, among the Æluroidæ, by the tiger.

Only three species of hyena now exist, and these are placed in two genera, viz., *Hyæna*, characterized by a large, deep, sub-anal gland, a long, transverse, tubercular grinder furnished with three roots, and legs nearly equal in length; and *Crocota*, distinguished by a small, two-rooted, tubercular grinder, and short hind-legs, as well as by peculiarities in the reproductive organs. Besides these true hyenas the family includes the singular Aard Wolf (*Proteles lalandii*), which, although similar in both appearance and structure to the true hyenas, and with teeth of the same general pattern, differs from them in the great weakness of its jaws, the smallness of its teeth, and the absence of the tubercular grinders of the upper jaw.

In the glacial period the striped hyena is believed to have inhabited the south of Europe, while an extinct form, *H. spelæa*, the Cave Hyena, probably a large variety



Hycena striata, striped hyena.

of the spotted hyena, adapted to brave the rigors of a cold climate, has left abundant remains in the caverns of England, France, and Germany. A fossil hyena is also found in the Himalayas.

In the Brown Hyena, *H. brunnea*, which is a native of Cape Colony, the general color is brown, clouded with darker, and the mane is much less prominent than in the next species. An anatomical distinction is the compressed form of the cavity of the brain as compared with the posteriorly swollen brain-case of the striped species. The



FIG. 202.—*Hyaena brunnea*, brown hyena.

hair is long and coarse over the whole body, reaching a length of eight or ten inches on the back and sides. The legs are marked with transverse black bands.

The Striped Hyena (*H. striata*) has a wider range than any other hyena, extending throughout nearly the whole of Africa, as well as eastward into Syria, Mesopotamia, Persia, and India. It is sometimes taken in the Himalayas, but rarely reaches the vicinity of Calcutta, though found everywhere else in India. The ground color is uniform brownish gray, rather darker above, and the sides are adorned by several indistinctly-bounded, distant, blackish cross-stripes, which are boldest below. These

bands become oblique on shoulders and haunches, and are continued on the outside of the legs by regular transverse lines. The hairs are long, and on the back of the neck and along the spine form a full, thick mane, continued even on the tail by tufted hairs longer than the rest. The markings and tint vary considerably. The strength of jaw possessed by this animal is enormous. The shin-bone of an ox is crushed with ease and the fragments swallowed entire. Ravenous yet cowardly, the striped hyena lives by day in caverns and other hiding-places, and sallies forth by night in large packs to devour the carcasses left by the lordly lion or other carnivores that hunt their prey. In the pursuit of food it often tears open graves, and devours the bodies of the dead, a habit that has made it the subject of superstitious dread. Though habitually feeding upon carrion and bones it often attacks living animals, and has been known to carry off donkeys from the midst of a village. Notwithstanding its fierceness and strength, it has and merits the character of a coward, so much so that to kill a hyena is, by the Arabs of Algeria, considered beneath the dignity of a hunter. The Arabs of Mesopotamia make sport of its cowardice, and assert that it understands Arabic. If, say they, a man crawls into the cave of a hyena with a noosed rope, and says to it, caressingly, "You are very nice and pretty and quite like a lion; indeed, you are a lion," the animal is so flattered that it will allow the rope to be put round its neck, and itself to be dragged out. The grip of the hyena is like that of the bulldog, when once it has fastened upon an object it is almost impossible to drag it away.

The striped hyena is supposed to be mentioned in the Old Testament, as it is believed that the phrase "the valley of Zeboim" (1 Sam. xiii. 18, Nehem. xi. 34) should be translated "the valley of hyenas." It does not appear to have been introduced into the Roman shows until the reign of the third Gordian. It has often been asserted that the hyena is untamable, but not only are instances to the contrary furnished by every menagerie, but in the countries inhabited by the creature individuals are domesticated, and made to do the duties of a dog.

The Spotted Hyena, *Crocota maculata*, has a much narrower range than the last, since it is confined to the southern part of Africa. It appears to be, as a rule, rather smaller than the latter species, and is of a yellowish brown color, the entire body covered with numerous spots of deeper brown, occasionally arranged in rows, and nearly equal in size. Compared with the striped hyena, the hair is shorter, and the mane, though present, is less conspicuous. The tip of the tail is dark. Although the spotted hyena is usually considered smaller than the striped hyena, it exceeds that species in the size of the skull, which seems to attain dimensions exceeded only by those of the lion and the tiger among the *Æluroides*, since Mivart records one which measured twenty-two and a half inches in length by more than eighteen in width across the zygomatic arches. In absolute length the neck of this species exceeds that of any other *æluroid* except the tiger, while the vertebræ of the loins, which in a wild cat are longer than the dorsal region, are in *Crocota* not two-fifths that length. The shortness of the hind-limbs is more apparent in this than in other hyenas; it is, in fact, the only *æluroid* in which the hind-limb is really shorter than the fore-limb. This is doubtless the animal which gave rise to the fable of the hermaphroditism of the hyena—a fable which was largely current among the ancients, and which Aristotle combats. The external characters of the two sexes so closely resemble each other that the belief was only natural in the lack of anatomical investigation, and it is evident from Aristotle's description that the species he speaks of is the striped hyena, in which the sexes can easily be distinguished by external characters.

The spotted hyena is more abundant and more destructive to the settlers of the Cape and adjoining districts than *H. brunnea*, as it not only devours dead animals, but carries off the smaller ones, and even kills some of the larger. It is said to be gifted with extraordinary cunning in avoiding traps and snares of all kinds, examining carefully every strange object, and usually deciding not to touch it. When hunting at night it continually utters its melancholy howl, calculated to inspire with fear all animals within hearing. Nor can human beings feel secure from it, for, not content with violating the graves of the dead, it has been known to steal noiselessly up to the camp-fires of the natives, and steal the children from under the mother's kaross.

For a long time the Aard Wolf (*Proteles lalandii*) was a puzzle to naturalists, and was bandied about between the dog and hyena tribes till it was given the distinction of a family all to itself, only to be finally relegated to a bottom seat among the hyenas. It is a native of South Africa, is about the size of a large fox, and has a mane of stiff hair along neck and back, and stripes upon its sides, so that, at first sight, it greatly resembles a young striped hyena. The hair is ash-colored, with a shade of yellowish brown, the muzzle is black, and the eight or ten dark brown bands down the flanks, and those on the thighs, are arranged much as in *H. striata*. The long hairs of the mane are gray, with two black rings, the second at the tip, and those of the tail are similar. The muzzle is long but broad; the legs long, the hinder appearing much the shorter from the crouching attitude of the animal; and the hinder surface of the tarsus is, as in all truly digitigrade animals, covered with hair. The grinding teeth are small and far apart—a great contrast to the massive molars of the true hyenas. There is no tubercular grinder above or below, the flesh-tooth of the upper jaw is small and triangular, the hindmost tooth of the lower jaw is rudimentary; and the first lower premolar is the largest of the series, is curved like a canine, and is separated from the canine by a wide space.

The Aard wolf lives by day in a burrow of its own construction, several individuals sometimes inhabiting the same burrow. The burrows have usually three or four entrances, so as to secure escape in case of attack. In its actions, as well as its appearance, it resembles the hyenas, bristling up its mane when angry, like the striped species, and having the hyenine habit of walking or crawling upon wrist and ankle-joints when fighting or defending itself, with the object of defending its feet from injury. Its physiognomy, its growl, its mode of snarling, are similar to those of the hyenas, from which it differs chiefly in the smallness of the teeth, and the weakness of the jaws and of the muscles, that in its relatives are so immensely developed to enable them to crush their solid food.

The VIVERRIDÆ, or Civet Cat family, have a much more elongated head and longer muzzle than the cat family, and usually possess two true molars on each side of each jaw. In the upper jaw both of these, and one in the lower, are tubercular. The teeth vary considerably in their shape, but are never as truly sectorial as in the cats. Many of the family possess scent-glands of considerable size.

The limbs are usually shorter in proportion to the trunk than those of the cats, and the claws are only partially retractile. Some of the Viverridæ are digitigrade, others partially plantigrade, and still others plantigrade, while the number of toes upon the hind-feet may be five or four. From the characters of the feet they have been divided into the cat-footed Viverridæ (civets, genets, etc.) and the dog-footed Viverridæ or Herpestidæ, including the ichneumons and their allies. The species are very numer-

ous, but their actual number is now shown to be less than was formerly supposed, and further investigation may still further reduce the catalogue.

In the Viverrinæ (civets, genets, etc.) the excavation of the middle digital phalanges for the reception of the retracted terminal ones is much smaller than in the cats, and this excavation is obsolete in the genus *Galidictis*, and its near allies, as well as in all the dog-footed Viverridæ or ichneumons.

This large family occupies a position between the more specialized and diversified families Felidæ and Hyænidæ. To the former it is to some extent linked by the curious *Cryptoprocta* of Madagascar, an animal which has until recently been considered to form the type of a distinct family, but which is pronounced by Mivart to be, spite of its cat-like dentition, truly viverrine in the sum of its characters. To the Hyænidæ this family is linked by the genera *Crossarchus* and *Suricata*. The



FIG. 203.—*Viverra civetta*, civet cat.

Viverridæ are confined entirely to the eastern hemisphere. The majority of the true-cat-footed Viverridæ are Asiatic, while the majority of the ichneumons are African, but numerous species of each group occur in both these continents. Two forms only, the common genet (*Genetta vulgaris*) and the common ichneumon (*Herpestes ichneumon*), occur in Europe.

The genus *Viverra* contains large forms with a robust body, vertical pupils, a long head with sharp muzzle, a ringed tail, and a back with a crest of black hair. All the species have a more or less white throat. The species are *V. civetta*, the African Civet, *V. zibetha*, the Zibeth or Asiatic Civet, *V. tangalunga*, the Tangalung of the Malay peninsula and East Indian archipelago, and *V. megaspila*, of Malacca and Cochin China. *V. civetta* has the tail nearly all black, and the sides spotted. It approaches three feet in length, without the tail, which is about half that length. It inhabits Africa at least as far south as the Gaboon on the western coast, and Abyssinia on the eastern. *V. zibetha* is spread through Hindostan, the south of China, and

Cochin China, extending to Formosa and the Malay peninsula. Its tail is ringed with black.

The scent-glands in *Viverra civetta* are each about twice the size of one of the animal's anal glands, and each gland opens into a large scent-pouch by a number of minute orifices, as well as by an opening from a central cavity. In *V. zibetha* the arrangement is similar. This pouch for the reception of the civet is absent in the genets.

The tongue of the civet is relatively longer, more slender and more pointed than that of the Felidæ, the conical papillæ are not horny, and there is no conspicuous patch of specially modified papillæ toward the anterior part of the upper surface.

The perfume of the civets is highly prized in the countries they inhabit, and is of some value as an article of commerce, so that they are often kept in captivity for the sake of obtaining it. It is stored in the scent pouch with which these animals are provided, and is obtained by scraping the inside of the pouch with a spatula. As the civet is a dangerous animal to handle, ready at the slightest provocation to use its teeth, and as a larger quantity of the valued scent can be obtained from an angry animal, the method adopted, both with *V. civetta* and the rasse, is to confine the animal in a cage so long and narrow that it cannot turn while the spoon is being used to scrape its pouch. The Abyssinians are especially fond of the perfume of the civet, as are the Javanese of that of the rasse. The latter people keep their room, their clothes, and themselves so strongly scented with the substance as to make their presence highly disagreeable to a European. The civets are usually inclined to sleep in the day, and hunt mostly at night; they feed chiefly upon birds and small mammals. Their character, even when domesticated, is said to be irritable and untrustworthy, yet the zibeth is kept in houses for the same purpose as the domestic cat, and is said to be quite gentle, and the African civet, at least when young, is fond of being stroked and caressed, and is most amusing from its inquisitive investigations of the garments and persons of those who fondle it. The genus *Viverra* may have two pectoral mammæ as well as four ventral ones, as in the paradoxures and ichneumons.

The genus *Viverricula* differs from *Viverra* only in having the orbits surrounded by bone. *V. malaccensis*, the Malacca Weasel or Rasse, inhabits India, China, the Malay peninsula, Formosa, Java, Lombok, Socotra, etc., and has along its back and sides seven dark or black stripes more or less broken into spots, some dark, lunate spots on the throat, no crest along the back, and a tapering, dark-ringed tail about as long as the body. In China there is a paler variety, with less distinct spots, and the species in general is very variable in color. It is much smaller than *V. civetta*, not exceeding twenty inches in length without the tail. Unlike the true civets, it has the habit of climbing trees.

To the genus *Genetta*, which differs from *Viverra* in the absence of a pouch for the civet, and in having a narrow, naked line along the back of the tarsus, and a longer tail, belong five species, the best known of which is *G. vulgaris*, the common Genet. This animal is blackish gray, spotted with black, and the tail is banded with black and white rings of nearly equal length. There is a black, slightly crested line of fur along the centre of the back. Its range extends all around the Mediterranean, including western Asia, northern Africa, and southern Europe. It occurs as far north as Nismes in France. It frequents lowlands, especially near springs and rivers. In Constantinople it is kept in the houses as a mouser, and is said to equal the cat at the business. In South Africa it is replaced by *G. felina*, the Musk Rat of the colonists, a darker species, and

in West Africa by the Senegal Genet, *G. senegalensis*, which is of a pale yellowish gray with brown spots, and is about twenty inches long. *G. pardina*, the Berbe and *G. tigrina* are also African. The genets are furnished with scent-glands, but secrete a perfume that is less powerful than that of the civets. None of them approach *V. civetta* in size. *Fossa daubentonii*, the Tambasading of the natives of Madagascar, is confined to that island and is grayish black, with black lines on the back and nape, reaching to the tail, but broken into spots behind; the under parts are dirty white, and the tail has many narrow half rings above.



FIG. 204. *Genetta vulgaris*, genet.

The Linsang (*Prionodon gracilis*) of the Malayan regions has only thirty-eight teeth, as the second upper tubercular grinder is missing. It is white, with broad, black cross bands. It occurs in Borneo, Java, and Singapore. A second species is found in Nepal, and a third in Darjeeling and South Tenasserim.

The Guinea Linsang (*Porana richardsonii*) is distinguished from *Prionodon* by the narrow, bald line upon the under side of the tarsus, as in the genets. It is pale brown, with black spots which on the back are square and large. It ranges from Sierra Leone to Fernando Po.

The group containing the genus *Paradoxurus* and its near allies is somewhat further removed from the true civets than are the genets and linsangs. They have a long curled or revolute tail of many vertebræ, and have the habit of curling up this tail as it lies on the ground. This habit causes the tip to be worn away at the sides in

individuals kept in confinement. The claws are semi-retractile, and scent-glands, which secrete a peculiar perfume, unlike that of the civets, are present.

The genus *Paradoxurus* contains several species, some of which are not well defined. All are Asiatic, and five at least are confined to India and Ceylon. The Musang (*P. fuscatus*) is a native of Java, Sumatra, Borneo, and Malacca, and has five more or less interrupted black streaks upon the body; *P. philippensis*, which is blackish with a silvery gloss, is a native of the Philippines, and *P. zeylanicus* is found in Ceylon. The last is about twenty-one inches in length. The most common and widely spread paradoxure of India is *P. hermaphroditus*, the Luwack, or Civet Cat of Malabar, which is a small, dark species, with three rows of black, elongated spots that are indistinct except in certain lights. Three other related



FIG. 205.—*Paradoxurus hermaphroditus*, luwack.

species are separated by Dr. Gray, under the name of *Paguma*, on account of the shortness of the flesh-tooth: of these, *P. larvata*, which is the smallest, ranges through China, Tibet, and Formosa; *P. leucomystax*, which is the largest, is a native of Sumatra and Borneo; and *P. grayi* inhabits Hindostan. *P. larvata* has a very broad nose and small teeth, and is gray brown with black head, feet, and tip of tail; while *P. leucomystax* has very large, massive teeth, and is blackish brown. Bennett states that the tail of the musang is prehensile, and that of *Paradoxurus prehensilis*, a Burmese species, which is long and very slender, exceeding the body in length, appears to have some slight prehensile power.

Paguma larvata, the Masked Glutton, owes its name to the white streak down the forehead and nose, and the white circle round the eyes, which make it look as though covered with a mask. The paradoxures live upon a mixed diet, and appear to be of the same fierce, irritable disposition that is attributed to the civets. A musang

or Java cat, taken young, and well treated by Mr. G. Bennett, was always fretful and snappish, growling, snapping, and spitting, and at night giving forth a continual squeak.

The Nandine (*Nandinia binotata*) has a very small hinder tubercular tooth, and a very small auditory bulla. The neck has three parallel black streaks, one from the forehead, and one from each ear, the back has numerous black spots, and the withers have each a yellow spot; but the size, number, and brightness of the spots varies. It lives in West Africa, and it is said to occur also in Zanzibar. It attains a length of two feet. *Arctogale trivirgata*, a species occurring along the eastern side of the Bay of Bengal and in the mountains of Java and Sumatra, has the orbits nearly complete, and the frenum of the tongue covered with hair. Another species of *Arctogale* inhabits Borneo. The teeth of this genus are small and unsectorial.

The Hemigale (*Hemigalea hardwickii*) has the lower part of the tarsus devoid of hair, numerous very long and rather rigid whiskers, and tufts of slender bristles on the throat, cheeks, and eyebrows. It is pale yellow, with black cross streaks, three on the head, two on the nape, and five across the back. Two rings near the base, as well as the tip of the tail, are black. The claws are retractile to nearly as great an extent as in the cats. It is found in Malacca and Borneo. *Galidictis vittata*, and its companion species, *G. striata*, are distinguished by the length of their claws, and by the longitudinal stripes, that run along the back and sides. These are in the former species, eight in number, and blackish brown, while the latter form has from seven to nine black streaks. Both inhabit Madagascar.

The genus *Arctitis*, which contains only one species, the Binturong (*A. binturong*), a native of Borneo, and probably of Sumatra, Java, and Malacca, is remarkable for its harsh, bristly fur, as well as for its thick, conical, and prehensile tail, by the aid of which it is enabled to climb trees. The ears are pencilled with hairs, the whiskers are numerous, long, and stiff, and the entire hinder part of the tarsus is bald and callous. In the young the first tubercular grinder is larger than the flesh-tooth, but in the adult the reverse is the case. The adult is black, younger examples have more or less white at the tips of the hairs, and the young are of a pale, dirty yellow. The harsh, bristly fur on body and tail, the long, brown whiskers, that not only fringe the upper lip but are present, though more slender, on cheeks, throat, and eyebrows, the dark color, and the short, sharp, slightly turned-up muzzle, combine to give this animal a singular appearance. It passes the day in sleep, lying upon its side with its head sheltered by its bushy tail, and when awakened utters a sharp, fierce growl, and settles down to sleep again. Its food appears to be of a mixed nature, as in captivity it relishes rice, fruit, and other vegetables as much as eggs, birds, and animal food generally. It is one of the largest of the Viverridæ, as the head and body measure about two feet six inches in length, and the tail equals or exceeds the body in length. The neck is very short. In absolute length of tail the binturong surpasses all other æluroids except the tiger. Mivart found the caudal vertebræ of one of these animals to measure nearly six feet ten inches in length, while the longest tiger's tail was but seven feet four inches. In relative length it is exceeded only by the genet and by *Nandinia*. The fourth premolar is but very slightly sectorial in this curious animal, which is also peculiar in having but five lumbar vertebræ, and in the absence of a gall-bladder, a peculiarity which is shared also by *Paradoxurus* and *Nandinia*.

A rather aberrant animal is the Mampalon (*Cynogale bennettii*), which is without the central longitudinal groove under the nose that is possessed by the civets, genets,

and paradoxures, has webbed feet, a very short, cylindrical tail, and is furnished on each side of each jaw with two tubercular grinders, the second of which is very large. It is a native of Borneo. The mampalon has very long, stiff whiskers along the sides of the muzzle, under the ears, and over the eyes, is plantigrade, and measures about eighteen inches in length, including the tail. This species is specialized for an aquatic life, is, in fact, a sort of viverrine otter. The molars are very large, especially the fourth.

The curious Madagascan cat-like animal, called by the natives Falanouc, or Falanaka (*Eupleres goudotii*), is viverrine, and is placed nearer to the civets and genets than to the suricate and its allies. It resembles the civets in the possession of a narrow, bald groove from the centre of the nose to the upper lip. It is rather larger than most of the family, measuring twenty-two inches without the tail, which is about half that length. It has a very small head, an extremely elongated nose, a bushy tail, and very



FIG. 206. — *Cryptoprocta ferox*, foussa.

small and peculiar teeth. The skull is three times as long as it is wide, the jaw is very light and slender, the lower incisors are smaller than the upper, and the canines are small and compressed, the upper one on each side rather smaller than the premolar following it, and the lower ones half the size of the next lateral teeth. The false grinders are compressed and widely separated from each other, the anterior ones resembling canines. The flesh-teeth are small and weak, and the tubercular grinder of the lower jaw far exceeds them in size. Thus the falanaka is a small-toothed viverrid, and occupies in this family a position analogous to that of the gray fox among the vulpine dogs. In color it is olive, minutely punctulated with yellow, and the cheeks, temples, and under parts are brownish white. It is stated to live in burrows.

The singular and fierce *Cryptoprocta ferox*, or Foussa of the natives of Madagascar, to which island its range is limited, is now classed with the Viverridæ. The foussa is of about the size of a large cat, and much like one, but its head is longer, and its ears and tail very long. The claws of all four feet are retractile, like those of the Felidæ,

but the creature is almost plantigrade. The under side of each foot has six pads. The teeth differ from those of the cat in the addition of a third premolar, both above and below, but the upper third premolars fall out early in life. Mr. Telfair, who sent the first example known to naturalists, says of it: "It is the most savage creature of its size I ever met with; its motions, power, and activity are those of a tiger, and it has the same appetite for blood and destruction of animal life." The foussa has an anal pouch, and when enraged emits a smell as disagreeable as that of a skunk. "When at liberty it lies constantly in a rolling position, sleeping always on its side, or even on its back."

In the sub-family of Herpestinae, or Ichneumons, the toes are slender, straight, and separate from each other, and the scent-glands are small or absent. The dimensions of the teeth are very constant, but their number by no means so. The majority of the species are African, but several are Indian, and one form (*H. ichneumon*) extends into southern Spain. The Asiatic forms all belong to the genus *Herpestes*. The best known species are the common Ichneumon (*H. ichneumon*), or Pharaoh's Rat, and *H. griseus*, the Mongoose of India. The first feeds to a great extent upon the eggs of the crocodile, and thus is largely instrumental in keeping down the numbers of these formidable reptiles. It also devours snakes, rats, lizards, and other creatures not in favor with humanity. Its usefulness in this direction caused the ancient Egyptians to domesticate it, and even to pay it divine honors. It is not confined to Egypt, but ranges over the whole of north Africa, extends into Spain, and occurs in Palestine and Asia Minor. In color it is gray, becoming brown upon the head and middle of the back; the feet and end of the tail are black, the latter ending in a long, flaccid pencil of hairs; the legs are reddish, as is the short under-fur. The head and body measure some twenty-one inches in length, the tail eighteen.

The mongoose is as highly valued in India as its congener is in Egypt, and is often kept tame about the houses for the services it renders in destroying snakes and other animated plagues. It is especially famous for its prowess in the destruction of the deadly cobra, a feat performed by force of its superior boldness and activity. It is smaller than the Egyptian species, and is gray, darker upon the head and legs and blackish upon the feet. The hairs are largely white-ringed.

H. caffer ranges over Africa south of the Sahara, and is rather larger than Pharaoh's rat. The color is similar, but the annulations of the long hairs are deep, shining black instead of brown or yellow, so that the tint is a clearer gray. The tip of the tail is black. *H. gracilis* occurs in the neighborhood of Cape Verd, also in Abyssinia, and thence southward to Natal. The typical form is dark brownish gray; another variety is dark rufous above and below, the hairs distinctly annulated with black, while a third is light sandy yellow, with similar annulations. In all these varieties the plan of coloration is similar, and no particular color is strictly confined to one locality, though there is a tendency in that direction. Another African species, *H. sanguineus*, has hitherto only been found in Kordofan, where Ruppell states that it lives in holes in the ground, among bushes. It is of a sandy tint. *H. galera* inhabits west and south Africa, and is a very large species, with a stout heavy body, and a tail shorter than the body without the head. The color is grizzled reddish brown and white, or dark blackish brown. The skull is very stout and heavy, especially the lower jaw, but the teeth are relatively rather small. The variety *robustus* is larger than the typical form, and is found upon the White Nile. This variety was first noticed by Flacourt (1661) in Madagascar, and was called by him the Vondsira. As it has not since been recorded from Mada-

gascar, Flacourt probably saw an introduced specimen. Some examples of this species have the soles of the feet devoid of hair, and these probably live on marshy soil, while those with hairy soles live on dry soil, and are less plantigrade in habit. Smuts says of this species that it lives in marshy places and on the banks of the smaller rivers, and feeds chiefly on frogs and crustaceans. Some individuals have no annulations upon the long hairs. *H. pulverulentus* resembles a small *H. caffer*, but has no black tip to the tail, and appears to be confined to the eastern half of Cape Colony, as it has not as yet been found north of Natal. *H. punctatissima* is a pale gray form, occurring in South and West Africa. The most aberrant African *Herpestes* is *H. albicauda*, which approaches the genus *Beleogale* in the length and bushiness of the tail, hairy tarsus, and large last molar with an extra external cusp between the two usual cusps. The general color is blackish gray, with the long hairs ringed black and white, the terminal



FIG. 207. — *Herpestes griseus*, mongoose.

third nearly always black. The under fur is woolly, of a uniform dirty gray, and the feet are black. Some examples have the tail entirely black, while in others it is almost entirely white. The skull is stout and heavy, and the brain-case not half the length of the head. This species occurs in West Africa, and also on the eastern coast from Abyssinia to Natal.

Of the other Asiatic species besides the well-known mongoose, the Garangau (*H. javanicus*) inhabits Sumatra, Java, and the Malay peninsula, and is abundant in the teak forests, while *H. urva*, or Crab-eating Ichneumon, inhabits the north of India, Aracan, and Afghanistan. The latter species is black, with a white ring near the ends of the long hairs. A white streak on each side of the body from the angle of the mouth to the shoulders is very conspicuous. Three other Asiatic species are known.

The African genus *Helogale* has only thirty-six teeth, and possesses a more rounded skull than *Herpestes*. The under side of the tarsus is naked, and the tail shorter than the body. The first small premolar is often absent in *Herpestes*, but in this genus

there is no gap between the canine and the second premolar. The species are very small. *H. parenta* of Natal is the smallest of all ichneumons, and *H. undulata*, of the Mozambique coast, is but slightly larger. The last species is of a rich rufous tint on neck, belly, and legs, with less black than is present in the grizzled upper parts. Peters states that this species is particularly fond of eggs, which it breaks by throwing them with its fore-legs between its hind ones at a wall or other object.

The only species of *Beleogale* is peculiar in the entire absence of the first toe of the fore-foot. In other ichneumons this member is very small, and is sometimes wanting, either through some accident in life or from want of skill in preparing the skin, but in *Beleogale* there is not even a trace of the corresponding bones of the hand. In this genus and in some other ichneumons the pupil contracts into a horizontally extended slit. The Meer-kat of the barren plains of southern Africa is the only species of the genus *Cynictis*. The toes are as in *Herpestes*, the first premolar is present, and the



FIG. 208. — *Crossarchus obscurus*, aevisa.

soles of the hind feet are hairy. The skull resembles that of the suricate, and has the frontal region very convex and the brain-case high. In color *C. penicillata* varies from very dark yellow to light yellowish gray. The long hairs are yellow at base, then follows a black ring, and the tips are white. The under fur is rich yellow, and the chin is white. The hairs of the very bushy tail are often two inches long; those at the tip are all white. This species passes the night in holes in the ground, but by day hunts mice, small birds, etc., or basks in the sun.

In habits all the ichneumons are very similar; quick and serpentine in their movements, they insinuate themselves, weasel-like, under crevices which seem too small for their bodies, and pursue their reptile prey into their most secret hiding-places. Inquisitive as is the cat, they examine every new object, and peer into every unexplored nook and corner. Gifted with great activity and much intelligence, they are more than a match for reptiles superior to themselves in size; but they are of independent, restless temper, fond of freedom, and not very reliable as pets.

The genera *Crossarchus* and *Suricata*, with, perhaps, one or two others, form a

group of ichneumons differing in the form of the skull and other respects from the more typical genera. *Crossarchus* has but three premolars, a flat palate, naked soles to the hind-feet, and a depressed skull. The banding of the back observable in this genus and in *Suricata* is produced by the regular arrangement of the long hairs, so as to bring the annulations into line. *C. zebra*, which inhabits Abyssinia, has cross bands on the posterior part of the back, is grizzled gray without a rufous tinge above, but has the chin, chest, and belly a more or less bright rufous. The two colors are divided by a sharp line along the sides. Below there is a more or less extensive central line of white. The tail is often black-tipped. The narrowness and whiteness of the cross bands enable this form to be readily distinguished. In *C. fasciatus*, the Banded Mongoose, the cross bands of the upper and lower parts are broader than in *C. zebra*, and the feet and tail become nearly or quite black at their extremities. This species is a native of Caffraria and Mozambique. The young are paler, and the cross bands indistinct. It is an energetic and lively little animal, extremely ready with its teeth, an agile climber, capable of springing from some distance, and very active in using its fore-paws.

The *Ævisa* of Guinea, *Crossarchus obscurus*, is of a uniform deep brown, rather paler upon the head, and measures twelve inches without the tail, which is seven inches long. The feet are almost entirely black. The skull is long and narrow, and the muzzle longer than in the other species. The teeth are very small. It ranges from the Cameroons to Sierra Leone. The Suricate or Zeniek, *Suricata tetradactyla*, called also Meer-kat at the Cape, is confined to southern Africa, and is grayish brown, with a tinge of yellow; several dark bands run across the back, and the orbit and tip of the tail are black. The head is nearly white, the ears black, and the tail yellowish, with a well-marked black tip. It is furnished with powerful claws, by means of which it can burrow tolerably well. In habits it is largely nocturnal, residing mostly in mountain caves, not relishing a bright light, and is a dexterous hunter of rats, mice, and other vermin, for the purpose of killing which it is sometimes domesticated. It is said to be an affectionate creature to those who treat it well, but to have a good memory of injuries. Its sense of hearing is said to be rather dull. There are only four toes on each hind-foot.

Rhinogale melleri is a peculiar east African animal, known as yet by only one example. It has five premolars above, the teeth are rounded, suited for grinding rather than cutting, and the last molar above and below is much larger than is usual. It is of a uniform pale brown above, but little grizzled, and has under fur of a dark gray, tipped with brown.

Most carnivorous of the Carnivora, formed to devour, with every offensive weapon specialized to its utmost, the FELIDÆ, whether small or large, are, relatively to their size, the fiercest, strongest, and most terrible of beasts. The reduction in the number of digits is slight, since all the tribe have five upon the fore-feet and four upon the hinder; while the structure of the terminal portion of each toe is highly specialized, each terminating in a short, hooked, compressed claw which, together with the last joint in which it is inserted, can, when not in use, be drawn upwards and backwards. This retraction of the claws is effected by special ligaments, and is so complete that their points never touch the ground or other surface on which the animal is progressing, except when the exercise of its will overpowers the ligaments. With their weapons thus kept sharpened ready for use, yet packed away safely among the soft

folds of the skin, the Felidæ steal upon their prey noiselessly; treading on the soft, elastic pads of the soles of the feet, without risk of betrayal from the rustle caused by non-retractile claws. When within a short distance, they crouch and spring, bounding many times their length upon their unsuspecting victims, which, borne down by the descending weight of the fierce foe, are at once fastened upon by the deadly grip of the well-armed jaw, and by the united action of eighteen fully-extended piercing claws.

The fore-limbs or arms are endowed with a freedom of motion almost equal to that of the primates, can be bent, extended and turned with the utmost ease and swiftness, and can deal a blow as readily as the fists of a man. A kitten playing with a ball, agile, graceful, dexterous, — gives evidence of powers which in the larger felines are sufficient to vanquish all but the very strongest of the herbivora.

To give this supple gracefulness and power of limb, the muscles of the Felidæ are highly differentiated — they are not partially distinct laminae, as in the more generalized raccoon (taken as an example of the Arctoidea), but clearly defined round muscles, through the centre of which runs the motor nerve. Correlated with the formidable paws is the no less formidable array of teeth. Of these the cats possess thirty — twelve less than the dogs, yet still a number sufficient to give every variety of tooth needed by a carnivorous mammal.

The usual dental formula is $i.\frac{3}{3}, c.\frac{1}{1}, p.m.\frac{3}{3}, m.\frac{1}{1}$. The reduction in number of teeth is not carried far, for the full set contains only two less teeth than that of the higher quadrumana, but, as in so many cases of reduction, is accompanied by a specialization and enlargement of certain of the remaining teeth. The canines are very long and sharp, while the sectorial teeth (the fourth premolar of the upper jaw, and the single molar of the lower), are relatively larger and more thoroughly adapted for cutting through the substance of living flesh than those of the dogs. The upper sectorial has usually a small internal process, while the lower is without the heel, and is a deeply-bifurcated cutting blade which closes scissor-like against the upper sectorial. The second premolar of the lower jaw is also a well-developed cutting-edged tooth, but the first premolar of the upper jaw is small, and in some species entirely wanting, while the upper molar is very small, and situated upon the inner face of the hinder end of the sectorial. The milk dentition of the Felidæ is $i.\frac{3}{3}, c.\frac{1}{1}, m.\frac{3}{3}$.

The body and limbs of the cats are covered by more or less soft, thick fur, the tail is well-developed and thickly-furred; the face is short and broad, without the lengthened muzzle of the dog; the papillæ of much of the surface of the tongue are horny, serving to lick the last remnants of flesh from the bones of their prey; the stomach is a simple much-bent bag, and the intestine is comparatively short. The Felidæ are the most completely digitigrade of the Carnivora, forming in this respect a complete contrast to the bears. Beneath the ends of the metacarpals and the metatarsals, upon which the animals rest in walking, is a large trilobed pad of fat and fibrous tissue. A similarly constituted smaller pad is placed beneath each of the toes, and a small one under the pisiform bone of the wrist of the fore-foot. The senses of the Felidæ are exceedingly keen; touch, sight and hearing are developed to the utmost, and scent, although inferior to that of the dogs, is acute compared with that of most mammals. The eyes are large, and the pupil possesses the power of contraction under the influence of sunlight, reducing itself in some forms to a vertical linear slit, in others to a small round aperture.

The characters enumerated are those of existing cats, which form only one section of one of two lines of forms, various species of both of which are found in the ter-

tiary strata of the Old and New World. The extinct species of cats fall, according to Prof. Cope, who has given the most thorough study to this group, into two series, one of which includes the genus *Felis*, and the extinct sabre-toothed genera *Drepanodon* (= *Machærodus*) and *Smilodon*, while the other contains a number of genera which differ from the true Felidæ in several characters, which show an approach to the lower Carnivora. These lower forms constitute Cope's family NIMRAVIDÆ, including six American genera and probably three European ones, and twenty-one known species, ranging from the upper eocene to the verge of the pliocene times. Three of these genera form a series having gradually enlarged upper canines, and leading to the genus *Hoplophonus*, which is furnished with immense sabre-like upper canines like those of the sabre-toothed true cats (*Machærodus*). Parallel with the increase in size of the upper canines goes a reduction in the number of molars and a decrease in size of the lower canines. Some of these nimravine cats were large. *Archæurus debilis* equalled a puma, but was weaker in teeth, jaws, and limbs; *Nimravus gomphodus* was larger and in every way more powerful; while *Pogonodon platycopis* was the equal of the largest Brazilian jaguar. The most highly-developed nimravine cats lived in eocene times, and were approximately cotemporary with the generalized *Pseudæurus*, which may possibly be the ancestor of the existing Felidæ. Thus it is evident that for the earlier ancestry of the feline group, for the steps which connect them with non-feline mammals, we must look back to the earliest eocene or perhaps to late mesozoic times, to strata which have at present yielded but few mammals, and none of those approaching the cats in structure. The true cats make their first known appearance in the miocene epoch, when the genus *Drepanodon* or *Machærodus* and some ounce-like cats appear in Europe. Nine species of *Drepanodon* are known from Europe and Asia, but none have yet been found in America, where the place of the genus appears to be taken by *Smilodon*, of which four species have been described, all belonging to the pliocene period, and cotemporaries of the gigantic sloths and *Glyptodons*, which then ranged the entire continent. "Their powerful limbs," says Cope, "terminated by immense claws, bespeak for them exceptional force in striking and tearing their prey, and the long compressed canine teeth are well adapted for penetrating the tough hides and muscles of the large Edentata which were doubtless their food." *S. necatur*, found in Buenos Ayres, is about the size of the lion, and is equalled by *S. fatalis* of Texas. In *S. necatur* the length of the canines equals the half of that of the head. The sabre-toothed division of the Felidæ, as well as the entire nimravine series, are extinct, and it appears probable, as suggested by Prof. Flower, that the excessive specialization of the upper canines, which is the only important character separating *Smilodon* from the existing Felidæ, was the cause of their disappearance.

The remaining genera of Felidæ, escaping the dangerous specialization which ended in a degradation of the powers necessary for existence, yet retaining great specialization in several directions, still exist. The researches of Mivart, who has specially studied the Æluroidea, bear out the ideas of the older naturalists in regarding the cats as a very homogeneous group, scarcely capable of subdivision into genera. The only genera admitted by Mivart are *Felis* and *Cynælurus*, the latter including the hunting leopard only. The lynxes are to some extent distinguished from the other cats by certain outward characters, such as longer legs, a pencil of elongate hairs upon each ear, and a shorter and more globose head. The nasal bones in the lynxes are entirely separated from the maxillary by the great development of the upward process of the intermaxillary and the downward process of the frontal.

The linear or rounded form of the contracted pupil appears to be to some extent correlated with the habits of the animal, as the more strictly nocturnal forms have a linear pupil, yet the tiger, whose pupils are round, hunts his prey at night, and the lion has the same habit. Although the larger cats are terrestrial, and the smaller arboreal in their habits, many haunt the banks of rivers to get their prey, and some contrive to feed upon fish. All detest the immersion of any part of the body in water, and drink but little of that element, the larger cats taking less than the smaller.

Mivart reduces the number of recent species to fifty, and speaks doubtfully of the distinctness of some of these, especially of certain South American and east Asian forms. The only species of the family common to both hemispheres is the northern lynx; only five species occur in both Africa and Asia; Europe has only the domestic cat, wild cat, and two lynxes, though the lion once ranged the forests; Africa has only five peculiar species (two doubtful ones excluded), and America can only claim ten or eleven well-characterized forms, of which two only, the puma and the lynx, are found in North America north of Mexico and an adjoining border-land. Asia is, therefore, the headquarters of the cat tribe, some thirty-five species of which occur within its limits. Although the Felidæ are, as now distributed, mainly a tropical family, yet the lynx ranges far into northern latitudes, the tiger hunts in Siberia, the ounce occurs at altitudes of eighteen thousand feet, where man finds it difficult to breathe, and has a high northern range; and *F. scripta* and some other forms inhabit cold and elevated regions. Such an extent of range, often in the same species, proves great adaptability to climate, especially as none of the species hibernate. Neither Australia, New Zealand, nor New Guinea possesses a single species of Felidæ; the large island of Celebes is believed to lack representatives of the family, and it is a singular fact that in the West Indies and Madagascar, situated in the centres of feline distribution in their respective continents, no native cat occurs.

The Cheetah or Hunting Leopard (*Cynælurus jubata*) is as large as a leopard or ounce, since the head and the body measure four and a half feet in length, while the tail varies from two and a half to two and three quarters feet. It is the least cat-like of cats, as it has long, slender limbs, a very short, round head, claws that are only partially retractile, and a second premolar that is very large, projecting downwards as much as the sectorial. The ground color of the upper parts of the adult is rufous fawn, with round, black spots scattered evenly over body, limbs, and cheeks; the tail is imperfectly ringed; the hair of the neck is rather longer than the rest, and that of the under parts is longer and lighter in tint than the back and sides. The coloration of the young differs widely from that of the adult. Long, soft, dark-brown hair, very obscurely spotted, covers the body, while the head and central part of the upper surface to the end of the tail are pale brown.

The cheetah can run for considerable distances with a swiftness equal to that of a well-mounted huntsman. The combination of dog-like powers of running with cat-like habits has been taken advantage of by man, who has tamed it for use as an assistance in the chase. When let loose upon the game, it will crouch along the ground and seek out every inequality of surface that may enable it to approach the antelope or deer without being observed. The cheetah inhabits the greater portion of Hindostan, though absent from some of the southern districts, and is found in Syria, Mesopotamia, and Persia. It also has an extended range in Africa, as it occurs in Senegal, in Kordofan, and near the Cape. The Woolly Cheetah (*Cynælurus lanæa*) has a thicker body, shorter and stouter limbs, and a thicker tail than the better-known kind. Its fur is



Felis tigris, tiger.

woolly, denser than that of *C. jubata*, especially on the ears, mane, and tail, and is of a pale isabelline color throughout, slightly paler on the belly, and covered all over with round, dark, fulvous blotches. There are no traces of the black spots found on its congener. Nevertheless Mr. Elliott regards it as only a variety. It inhabits South Africa.

Largest of all existing cats, in length and bulk exceeding the lion, but lacking the thick mane and tufted tail, is the Tiger, *Felis tigris*, the Royal Tiger, as it is often called. Each side of the face bears a tuft or whisker of long hair, often nearly white, as is that of the lower surface of the body, but the upper parts and sides are marked with dark stripes arranged nearly at right angles with the body or limbs, and standing boldly out from the bright rufous fawn or tawny yellow ground color. Some of the dark bands which cross the back are double, and the tail is ringed with black. The maxillary bones of the tiger end bluntly, and do not reach so far back as the large nasals — the reverse of what obtains in the lion; the hyoid bone is connected with the skull by ligaments, and the pupil is round. The range of this immense cat, which sometimes attains a length of ten and a half or even eleven feet, is much more extensive than was formerly supposed. Far from being confined to India, it extends thence westward through Persia as far as Turkish Georgia and Mount Ararat, eastward to Birmah and the neighboring countries, southward along the Malay peninsula to Sumatra, Java, and Bali; and, what is still more contrary to once received opinions, since it furnishes us with a proof that a so-called tropical animal can adapt itself to a temperate and even a cold climate, northeastward and northward through China to Manchuria, the Corea, the island of Saghalien, and the basin of the Amoor, even into Siberia. Strangely enough it is absent from Ceylon, and also from Borneo.

In Hindostan this creature is very common, notwithstanding the comparatively thickly settled state of the country, and is greatly dreaded by the natives, not only for the damage it inflicts upon their herds of cattle, but because it not unfrequently attacks man. A cattle-eating tiger will kill an ox about every five days, and may thus destroy sixty or seventy head of cattle in a year. The usual mode of killing its ponderous prey is to seize it with the teeth by the nape of the neck, holding the creature firm with its paws, while with a powerful wrench it dislocates the vertebrae. Thus a tiger confined in an arena with a buffalo is at a disadvantage as it is unable to find a hiding-place from which to spring, while the buffalo, having its opponent in full sight, and aware of its own strength and the formidable nature of its horns, chases the tiger around the enclosure without allowing it time to crouch for the fatal leap. Some tigers have, however, met these tactics by a change of method on their own part. Springing aside, and allowing the infuriated but clumsy bull to pass, they have brought it to the ground with a stroke of the strong fore-paw, and finished it at leisure. Like many other carnivorous animals the tiger at times indulges in cannibalism. Jerdon relates an instance in which a wounded tiger was carried off and partly eaten by another tiger. The males are said to destroy every young one of their own sex that they come across.

The Lion, *Felis leo*, has for ages borne the proud title the "king of beasts," and the adjectives noble, magnanimous, brave, with many others of lofty import have been bestowed upon it. Noble, indeed, is the port of the male lion, in all the glory of his tawny hide and long mane, yet he is but a cat after all, brave when hungry and in the dark, cowardly, or lazy at least, in the day-time, and magnanimous when not in need of food. No longer can the lion claim to stand at the head of the

feline tribe, for measurements have proved the tiger to be the larger, and the result of combats between the two leaves no doubt that it is the stronger. Much of the majesty of the male lion is due to the copious mane of long and shaggy hair that covers the top of the head, neck, and shoulders, and depends also from the throat, giving him the appearance of greater stature and larger size than he actually possesses. The mane does not begin to grow until the animal is three years old, and attains its



FIG. 209. — *Felis leo*, lion, South African form.

full development in three years more. The lioness is much smaller than her mate, and her want of a mane causes the difference to appear greater than it is. The yellowish brown color of the fur varies in its depth of tint, as does also the mane, which is often dark or even blackish, but adults never show any trace of spots or bands. There is a tuft of black hair at the tip of the tail. The young have a black line along the back, and little, dark cross-bars on each side of the body. The 'claw' with which the tip of the lion's tail was said to be furnished has been proved to be only the bare tip of the skin of the tail itself.



Felis pardus, leopard, panther.

All the characters which separate the last species from the smaller cats are shared by the lion, but the maxillary bones reach farther back than in the tiger. A full-grown male lion is at least nine and a half feet in length without the tail, and its weight six hundred pounds or even more. The duration of life is thirty years at least, and it is said that sometimes it attains forty.

From its size and weight it is unable to climb trees but lives upon the plains and deserts of the countries it inhabits, hiding in thickets and jungles when not engaged in hunting. Its present range extends through the whole of Africa, and eastward through Arabia into Syria and Persia. It occurs also in western Hindostan, occasion-

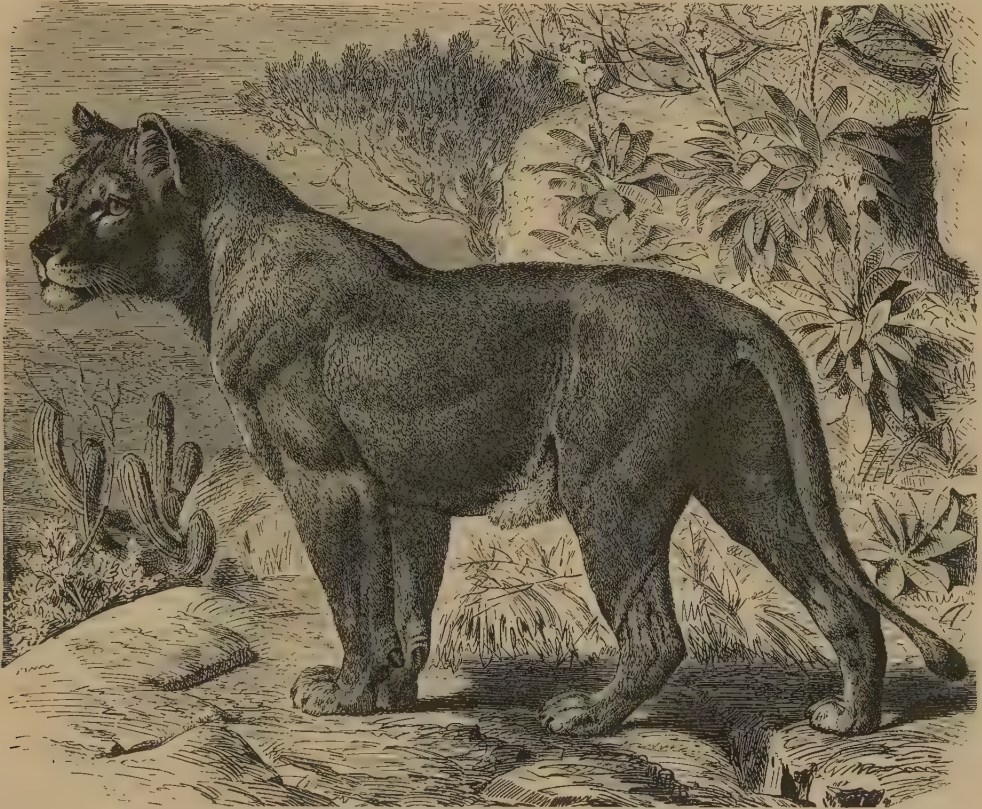


FIG. 210. — *Felis leo*, lioness, Senegal form.

ally as far east as Allahabad, but seems to be becoming scarce. It formerly roamed over central India, where it was killed as late as 1851, and we have historical evidence of its occurrence in Thrace (Roumelia).

The Leopard or Panther (*Felis pardus*) is far inferior in size to the lion or tiger, and is certainly smaller than the jaguar of America, but is sufficiently large to be a dreaded foe to man, as it commits havoc among his flocks and smaller domestic animals, although its ambition does not reach to adult cattle; is dangerous to man himself when wounded or cornered, and will not scruple to attack women and children. The head and body are about three feet ten inches long, and the tail is only slightly shorter. An adult skull measures nine and one-quarter inches in length, and five and

five-eighth inches in width, against fourteen inches and ten and one-eighth inches, which are the dimensions of that of a large tiger, but a comparison of these dimensions, taken by themselves, would be to the disadvantage of the leopard, which has the shortest skull, relatively to the length of the spine, to be met with in the entire æluroid series. The leopard is very variable both in size and color, so that it is possible that several species may be included under the title. It is usually of a yellowish fawn color, with darker spots grouped in rosettes over the whole of the body except underneath, where the tint is whitish. The cheeks are without long hair, and the tail is ringed.

The black leopard is certainly not a distinct species, but only a conspicuous example of that melanism, or tendency toward a dark tint, which displays itself in some



FIG. 211. — *Felis pardus*, leopard.

habitats more than in others. Dark though the fur of the so-called black leopard is, the usual spots are very evident when viewed in certain lights.

Unlike the lion and tiger, the leopard is arboreal; its residence is in the forests, and it is known in Hindostan as the tree-tiger. Its range is extremely wide, a circumstance which probably accounts for much of the variation it exhibits, the varieties being geographical races that have not yet developed into species, since the intermediate links still exist. It extends through the whole of Africa and the entire width of Asia, from Asia Minor and Palestine to Japan and northern China, as well as into Ceylon and Java.

M. Milne Edwards appears to believe the panther of Japan to be distinct, and he also describes, under the name of *Felis fontanierii*, a large panther-like cat, the type specimen of which measured about three feet ten inches in length, and was procured in the north of China. Another has been obtained from Persia. It is distinguished from



Felis concolor, puma, cougar.

ordinary leopards by its long, soft and very thick fur, and by the confluence of the black spots upon the back and sides into complete rings like those of the jaguar. These rings have no central black spot, and are large, forming only six or seven longitudinal rows. The tail is marked with large black spots forming almost complete rings. These peculiarities of fur and color are accompanied by a very short muzzle, narrow forehead, short palate, and longer base of the skull than in the typical leopard. Nevertheless, the species is not admitted by Mivart, and is probably but a geographical variety; while the *Felis tulliana* of Valenciennes, which has been confounded with the ounce, is nothing but an unusually pale and long-haired variety of the leopard. Some Persian leopards have somewhat similar characters. The leopard is found fossil in the south of Europe.

The Ounce, *Felis irbis*, is at least as large as the leopard, since it attains a length of four to four and a half feet without the tail, which is a yard long. It appears to be pre-eminently adapted for a residence in cold climates. Its range is very extensive, stretching across central Asia from the Himalayas to the Altai Mountains and Siberia, eastward into China, the basin of the Amur, and the island of Saghalien, and westward into Persia. The fur is dense and long, forming a short mane on the back, and lengthened in front of the breast, it is of a pale yellowish gray, marked with small irregular dark spots on the head, cheeks, neck and limbs, and on the back and sides with dark rings. Below there are a few large dark spots in the midst of the whitish color of the abdomen, and the tail is surrounded by incomplete black bands. The nasal bones are remarkable for shortness and breadth, the face is very short and broad, and the forehead is suddenly elevated, so that the profile is concave. Upon the Himalayas it is found at heights of from nine thousand to eighteen thousand feet, and it rarely descends much below the snow line. It is said to frequent rocky ground, and to feed upon dogs, goats, and sheep, both wild and domestic, but not to attack man. The immunity of man from its attacks must be correlated with the thinness of the population in the countries inhabited by it, as compared with those in which the leopard abounds, and with the comparative plenty of wild herbivores.

The much named species, the Puma (*Felis concolor*), ranges the whole of both the Americas, from the Straits of Magellan to where the increasing cold northward of Canada blocks its passage. As the American Lion, the Cougar, the Carcajou or Quinquajou, the Lion, the Panther, the Catamount, and the Painter, as backwoodsmen often entitle it, it figures largely in all books of travel and romantic adventure, the scene of which is laid in America, and is the one feline animal that has power to injure man or his flocks in those parts of the western hemisphere where the more powerful, but more tropical, jaguar does not penetrate. Panther-like in its habits, lion-like in its tint, some of its names are readily explicable, but the titles of carcajou and quinquajou are examples of mistaken identity, since they refer to quite a different animal; while that of cougar is a French abbreviation of the names gouazouara or cuzuacurana, applied to it in South America. Mivart gives the length of the head and body of the puma as about forty inches, but this is certainly far below the dimensions of a well-grown animal. The skull measurement given by Dr. Gray is seven and seven-eighth inches long, and five and three-eighth inches wide—dimensions equal in width, though not in length, to those of the leopard-skull, the size of which is given. The head of the puma is smaller in proportion to the body than that of most cats, the leopard excepted. In the Woodward museum at San Francisco is a puma as large as a lioness, measuring four feet ten inches from snout to root of tail. The height at shoulder is two feet, one and a half inches.

The skull is remarkable for its depth anteriorly, and the hyoid bone, as in the cat, is connected with the skull by a continuous chain of bones, instead of by ligament, as in the preceding species. In color the fur is of a uniform reddish brown or reddish gray, becoming lighter below, but without markings of any kind. The young are marked with several rows of blackish brown short streaks and spots along the back and sides, but these disappear about the end of the first year. Pigs, sheep, deer, and the smaller herbivorous mammals generally, fall a prey to the puma, but the peccary, and, in South America, the capybara, are said to be its favorite food. In districts where it has learned to dread the power of human weapons, it does not attack man unless compelled to do so in self-defence, but is a dangerous foe when aroused, though far less dreaded by the natives than the more powerful and ferocious jaguar. No roar, like that of the lion or of the tiger, escapes from the throat of the puma when upon the hunt for its prey—it creeps on stealthily, unheard as well as unseen, without awakening the fear or the prudence of its victims.

In Guiana the puma is known as the deer-tiger, and the Indians say that it imitates the bleating of the forest deer so well that men as well as deer are deceived by it. The Indians of northern California, where the puma still flourishes, and attains its largest dimensions, state that the grizzly bear and the puma have a mortal hatred of each other, but that in single combat the latter is always victor. This is borne out by the finding of the bodies of grizzlies that have evidently perished in a struggle. In revenge the grizzly kills every puma kitten he can find. In the vicinity of the McCloud River panthers are very common, and Mr. Livingston Stone found their tracks to converge to the foot of a cliff some twenty feet high at the foot of Mount Persephone. The home of the clan is above the cliff, which, though quite inaccessible to man, is habitually cleared at a spring by the strong-loined panthers.

The Jaguar (*Felis onca*) is the largest and strongest of the American Felidæ, and is certainly the third most powerful of the entire tribe. It is the tiger of the New World, and has a character for ferocity far surpassing that borne by its more widely distributed companion, the puma. On a superficial examination its markings resemble those of the leopard, but the spots are larger, cover a greater proportion of the ground, and are grouped into more angular patterns, each ring enclosing one or more dark spots. There is, however, so great a range in the coloration, even in individuals from the same locality, that it is not unlikely that two or three distinct species may really exist. Apart from this, there are geographical variations, for the most southern forms are said to be yellow or even almost white.

In North America the jaguar does not extend further than the Red River of Louisiana, and the Medina River, Texas, but its range comprehends the entire continent of South America except the colder parts of Patagonia. In Texas it extends eastward to the Guadalupe River. The forest-clad banks of rivers are the haunts of this species, which is most abundant, best developed, and fiercest in the immense and comparatively unexplored forests of the Amazon and its mighty tributaries. Here he reigns supreme, the terror of the forest, as the lion is of the desert, or the tiger of the jungle; the acknowledged and dreaded foe of man and quadruped. But the struggle for life is a fact for the jaguar as well as for many weaker animals, and he would often go hungry were it not for the abundance of the largest, but by no means the most pugnacious, of the rodents, the clumsy, timid, slow, and unarmed capybara. Monkeys are a favorite diet, but are difficult to obtain, for all the little Cebidæ of South America are too agile for him, and too wide-awake—except when asleep.

Peccary is also much to the taste of the spotted hunter, but peccaries are usually in herds, and the jaguar, like the puma, is incapable of contending successfully with a band of these fierce and fearless little pigs.

In procuring fresh peccary, the jaguar, according to both Belt and Brown, has recourse to astuteness. Springing among the herd, he kills one by breaking its neck, and then leaps up in to a tree, where he stays until the enraged herd of little pigs, weary of waiting for their revenge, disappear in the forest, when he comes down and eats his pig in peace. According to Belt, the crafty creature sits quietly upon a



FIG. 212.—*Felis onca*, jaguar.

branch, waiting for the peccaries' arrival, while, according to the account given by the Indians to Brown, he persistently follows up the herd, laying in wait for a wanderer, and springing into the nearest tree when pursued. It is told how a jaguar once sprang into a fallen tree, too low to put him out of the reach of the savage pigs, who dragged him down, trampled upon him, and ripped him to pieces.

The skull of the jaguar may be known from that of all other large cats by the prominence of a bony tubercle on the middle of the inner or nasal edge of the orbit, probably for the attachment of one of the muscles of the eyeball. The female brings forth from two to three young. Some naturalists believe there are as many as three species of jaguars, a larger and smaller spotted kind, and a black

species. Certain it is that the black jaguars are usually larger than the spotted ones.

In Guiana this black variety is called the Wallah, is supposed to be particularly given to the chase of the tapir, whence it is called the tapir-tiger, and is said to live at the bottom of pools, a belief which seems to have arisen from the circumstance that it haunts the neighborhood of deep places in the rivers, and has been seen sleeping upon rocks in mid-stream. The roar of the jaguar is loud, between a cough and a growl.

Perhaps the most handsome of the entire tribe of cats is the Clouded or Tortoise-shell Tiger (*Felis macrocelis*), striped and spotted in so irregular a way that description is difficult. The ground color is gray, tinged with brown, and the markings vary from stripes to spots and rings, but the cheeks and sides of the head are always marked with two parallel bands, one extending from the eye to below the ear, the other passing backwards from above the angle of the mouth.

The skull is very long and low compared with that of any of the species previously described, the orbit is widely open behind, the produced face lies almost in the same plane with the forehead; the nasals are large; and the hinder entrance to the nostrils is very narrow. With these peculiarities of the cranium goes one of the teeth — the first upper premolar, present in all the cats previously described, is wanting, and the second is not large. The upper canines are longer compared with the creature's size than those of any living cat (though they are insignificant beside the huge sabres of the extinct *Machærodus*), and the upper sectorial tooth has a large cusp. The pupil is neither round when contracted, like those of the larger cats, nor linear, as in most of the smaller, but an upright oblong. The Clouded Tiger is generally described as an exceptionally gentle cat, and such was certainly the character of two possessed by Sir S. Raffles, and by one of the two in the Zoölogical gardens at London, but another individual kept at the latter place was exceptionally ill-tempered and savage, so that, with tortoise-shell tigers, as with men, temper appears to be an individual characteristic, having little or no relation with carnivorous or herbivorous habits. This species does not appear to be dreaded by the natives of Sumatra, as it confines its depredations to the smaller animals, as sheep, goats, pigs, or dogs, and is said to be very fond of poultry. In Sumatra it is called Rimau-dahan, the last half of which word signifies a forked bough, from its habit of lying in wait stretched along the branch of a tree, with its head in the fork. Its range is comparatively restricted, yet is far larger than at first supposed, since it inhabits the eastern Himalayas, and farther India to its southern extremity, extending thence to Sumatra, Borneo, and Java. Northward it reaches to Formosa. The length of its body is about three and a half feet, while its long tail measures thirty-two inches.

The European Wild Cat (*F. catus*) is still found in Scotland, southern Russia, Turkey, Greece, Hungary, Germany, Dalmatia, Spain, and Switzerland, as well as in parts of western Asia. It is probably not the ancestor of the domestic cat. In Roman times it was common in England, where it is now extinct, and in France, where it is very rare. During the Middle Ages its fur was commonly used for trimming dresses, and a canon of the year 1127 forbade any abbess or nun to wear more costly fur than that of lambs or cats. It is supposed to have latterly increased in numbers in Scotland, especially in Inverness, Ross, and Sutherland counties, on account of the abundance of rabbits. Dr. Hamilton, who has carefully collected and examined the evidence, believes that it never existed in Ireland, and that all Irish wild cats are the progeny of domestic cats run wild.

The wild cat is larger and more strongly built than the domestic cat, and has a stouter head and a shorter, thicker tail, which does not taper. Its whiskers are more abundant, and the soles of the feet of the males are deep black. In color it is usually yellowish gray, with a dark streak along the back, numerous darkish stripes down the sides and across the limbs, and a black-ringed tail, with a black tip. One killed near Cawdor Castle, Scotland, measured, from nose to tip of tail, three feet nine inches.



FIG. 213. — *Felis catus*, wild cat.

It is a very savage animal, even as a kitten. The female makes her lair or nest in the hollows of trees and clefts of rocks; or even uses the deserted nest of some large bird, and goes with young sixty-eight days. Some naturalists believe the domestic cat to be descended, at least in part, from this species.

The Common Cat, *Felis domesticus*, the pet of the children, whom she allows to take liberties that no dog would permit to pass unpunished; the favored possessor of paterfamilias' knee as he sits by the fire in the evening; the home-like tenant of the

hearth-rug, and the terror of rats and mice; who dare say that the cat stands far behind the dog in the esteem of the human race? Many prefer the cat. She is cleanly and unobtrusive compared with her barking, obstreperous rival, and notwithstanding the vilifications of many popular natural history writers, she is affectionate and intelligent, and will often prefer to follow the family in its removals, although a certain nostalgia prompts her to make occasional visits to her old hunting-grounds. Cats have often been known to carry their affection so far as to follow members of the family in their walks, in spite of their natural repugnance to unnecessary daylight pedestrianism, and some have been known to sally forth to meet their masters at the hour they were accustomed to return.

Our domestic cat is probably descended from the domestic cat of Egypt, — the cat which is painted on the walls of Egyptian temples, is mentioned in inscriptions as early as 2000 B.C., was an object of worship and an inmate of temples, and was carefully embalmed at death. Pasht, or Bubastis, was the goddess of cats, and at Beni-Hassan is a temple dedicated to her, date 1500 B.C. So venerated was the cat in some cities of Egypt that when one died a natural death in a house the inhabitants shaved off their eyebrows in token of grief, yet in other cities (at least at an earlier date) it was not held in such esteem, for the earliest allusion to it is as “the impure cat.”

The eyes of cats are susceptible of changes of color, and the Egyptians believed that they changed each lunar month. The cat was domesticated in Europe before the Christian era. The Greeks probably obtained it from Egypt (though it has been suggested that their rat-catcher was the white-breasted marten), and the Romans certainly had it, for a painting of one was found at Pompeii, yet the marten appears to have been kept also by them.

The various breeds of cats are principally distinguished by color, and length, and quality of fur; but the Angora, or Persian cat is larger, and is believed by some naturalists to be descended from an Asiatic cat with a short tail. It is usually uniform white or yellowish, often with flesh-colored paws and lips. The tabby cat resembles the European wild cat in some respects, and Mivart thinks it may be the result of crossing.

In the tortoise-shell breed (fawn-color, mottled with black) the males are usually sandy, — a tortoise-shell male is rare, and so is a sandy female. Black cats usually have a white mark on the throat, and their eyes are clear yellow; while white cats may have the usual yellowish eyes, or may have one or both of the eyes blue. A blue-eyed cat is generally deaf. The blue, or Carthusian, is a beautiful breed, with long, soft, grayish-blue fur, black lips, and black soles to the paws.

The tailless cats of the Isle of Man are celebrated, but there is also a tailless breed in the Crimea. The tailless Manx cat has only three caudal vertebræ, and the sacrum, unburdened by the support of a tail, is relatively shorter than in other cats.

Among singular breeds of cats may be mentioned the Mombas cat, of the coast of Africa, which is said to have short, stiff hair instead of soft fur; the Paraguay cat, which has short, shiny, scanty hair, lying close to the skin, and is only about one-fourth the size of our domestic cats; and a South American breed, which is said not to give forth the unmusical cries by which ordinary cats express their feelings.

The cat begins to reproduce at the end of her first year, and continues to do so till her ninth, bringing forth from four to six young (sometimes more) two or three times a year. Twelve years appears to be the usual length of life, though eighteen may be reached under favorable circumstances. The milk incisors commence to appear when the kit-

ten is between two and three weeks old; at the end of the sixth week the first set is complete, and after the seventh month it commences to fall out, but the lower true molar is in place before the deciduous molars disappear.

The intelligence of the domestic cat has usually been supposed to be less than that of the dog, but the difference, if it exists, may fairly be attributed to the more recent domestication of the former, and to the far smaller amount of labor bestowed upon her education. Well-authenticated accounts of cats that have learned to open a latch, and to use the knocker of a door to attract attention to their wish to enter, prove great intelligence in some of the race. Very clever was the cat which, as related by Mivart, was in the habit of catching starlings by getting on a cow's back and waiting till the animal approached the birds, which little dreamed what crouched upon the back of their familiar companion.

The power possessed by cats of finding their way home by roads which they have never before travelled is a singular and almost inexplicable one, since the inferior power of scent possessed by them precludes us from attributing it to the reversal of remembered smells. But we are as yet far from a clear comprehension of the senses of animals, both in points in which, as in this case, they are more perfect than our own, and in points where they are much more generalized. The cat may possess a highly developed 'sense of direction,' such as some men possess, while others seem deprived entirely of it.

The mother cat has great affection for its young as long as they take nourishment from her, and this affection will sometimes manifest itself toward a foster-kitten. The writer recollects well punishing a half-grown kitten for some offence against home propriety. A fine old cat, which, since her own kittens had been taken away, had fostered this stranger, immediately flew at him in the most infuriated manner, her maternal feelings thoroughly outraged by the interference with her charge, and it cost some trouble and scratches to get rid of her.

The Fishing Cat, *Felis viverrina*, is remarkable for its manner of living. The common cat is very fond of fish, as every child knows, but this species carries its liking for finny food to such an extent that it overcomes the proverbial feline aversion to water for the sake of obtaining it, and actually goes fishing, adroitly snatching out with its paw any fish incautious enough to come within its range as it sits waiting and motionless. When fish are scarce it will make a meal upon fresh-water clams and snails, but it has been known to keep up the feline character for rapacity by occasionally carrying off a child, a feat that it is well able to perform, since it measures thirty-two inches in length, without the tail, which is rather short. The first upper premolar is present, but is small; the fur is short, and rather coarse, and the animal is said to have a disagreeable smell. The ground color is usually dark gray, sometimes inclining to reddish gray; the head and back have three or four dark brown longitudinal lines that break up into spots posteriorly, and all the upper parts are diversified with dark brown spots. The cheeks are barred with blackish brown, and the throat and breast, which are white, are crossed with blackish brown lines, passing from shoulder to shoulder. The belly is colored like the flanks, but marked with transverse lines of spots. The form of the pupil is variously reported. It is a native of Bengal, from whence it extends into China, Burmah, and Malaysia, as well as southward to Travancore and Ceylon, and some distance up the Malabar coast.

The Leopard Cat (*Felis bengalensis*) is either very variable in color and markings, or there are, as enumerated by Dr. Gray, four or five distinct species. The ground

color varies from pale yellowish gray to bright tawny yellow, reddish gray, or even greenish ashy or brownish gray; the under parts are pure white; there are four oblong spots on the forehead, and in the same line four bars run backwards to the shoulders, the two centre ones continuing almost to the tail. The shoulders, back, and sides are marked with longitudinal rows of oblong spots, changing to round on the belly; two narrow lines run from the eye to a transverse throat band; and the breast has two similar bands. The soles of the feet are dark brown, and there is generally a small white line over the eyebrows. It is found in Nepal, Thibet, Assam, Burmah, the Malay peninsula, Sumatra, and Java. The head and body are only from twenty-two



FIG. 214. — *Felis marmorata*, marbled tiger-cat.

to twenty-six inches in length. Smaller still is the Wagati (*F. wagati*) if indeed it is distinct from the leopard cat, from which it differs in its more defined short black stripes, and in the absence of the small spots on the flanks.

Among the other small-sized Asiatic cats is the Bay Cat (*Felis aurata*), which is of a bay red above, becoming paler on the sides and reddish white below, with a few indistinct spots on the flank, two black streaks on each cheek, and a pale black-edged line over the eyes. Its pupil is said to be round. Nepal, Sikkim, Sumatra, and Borneo, are recorded as habitats of this cat, which is of about the size of *F. viverrina*.

The Marbled Tiger-cat (*Felis marmorata*) is a small and very distinctly marked species, with round black spots on the lower part of the flanks and thighs, and wavy irregular patches of a darker shade of the ground color (dingy fulvous) on the upper

parts — these patches with dark margins, especially behind. The body is nineteen to twenty-three inches long, the tail fifteen. The pupil is linear. *F. marmorata* inhabits Nepal and ranges thence through the countries east of the Bay of Bengal to Java and Borneo.

Fontaineir's Spotted Cat (*F. tristis*) of China, is rather large, since the type specimen measures thirty-three and a half inches in length; it is of a whitish gray color, with three or four blackish lines along the back, and large dark brown spots on the rest of the body and the limbs. The tail is less than half the length of the body. The well-known traveller, the Abbé David, discovered the Thibet Tiger Cat (*F. scripta*) in the mountains of Thibet. Its markings somewhat resemble those of the clouded tiger, forming on the shoulders undulating bands that look a little like Chinese writing. The rest of the body has irregularly shaped spots with more or less



FIG. 215.— *Felis minuta*, small cat.

complete black margins. It is small, twenty-one and a half inches long, tail half that length. The Rusty-spotted Cat (*Felis rubiginosa*) is a pretty little cat, not more than sixteen or eighteen inches in length, and of a greenish-gray hue with four dark brown stripes on head and neck, breaking up posteriorly into rusty-colored short streaks. Roundish spots of the same tint are upon the flanks, and the face has two dark streaks and a white line over the eye. It inhabits the Madras coast and Ceylon, frequenting the brush-wood and grass of the dry beds of banks, as well as the jungle. The Chinese Cat (*F. chinensis*) is a yellowish gray species inhabiting Formosa and the south of China, easily known by the long white marks on each side of the nose and along the cheek bones. Dark brown spots, occasionally forming rosettes, adorn the back and sides. The orbits are nearly enclosed by bone. The head and body measure twenty-five inches in length. The Small Cat (*F. minuta*) is rather smaller than *F. chinensis*, with a shorter tail, but is similarly marked. It ranges through the Indian archipelago, and is found in the Philippines.

Jerdon's Cat (*F. jerdoni*) is about seventeen inches long, with a few black spots on a gray ground, and inhabits Hindostan; the Javan Cat (*F. javanensis*) may prove distinct; the Bushy-tailed Red-spotted Cat (*F. euphilura*) is a Chinese species of about the size of the common cat; the Small-eared Cat (*F. microtis*) is a long-haired Mongolian and Chinese form, with two white spots on each of its small ears; the Large-eared Cat (*F. megalotis*) is a native of the Indian Archipelago, and is yellowish with hairs annulated with black, and some stripes on limbs and face; the Indian Wild Cat (*F. torquata*) is much like the European wild cat, but smaller, less striped, redder, and more slender; the Ornate Jungle Cat (*F. ornata*), a native of the deserts of north-western India, has a very short tail and small spots equally distributed; the Steppe Cat (*F. caudatus*) of Bokhara is pale yellowish, and has very numerous small spots and a long tail; *Felis shawiana*, of Turkestan, Yarkand, and Kashgar, has a very long skull, a tail only one-third the length of the body, and a spotted abdomen; and the Manul (*F. manul*) of Thibet, Siberia, and Mongolia, is rather smaller than the common cat, of a pale whitish color, with a few narrow, black bands on the loins, a small black mark on the chest, a white, black-bordered streak behind the eye, and a black mark behind each ear. The fur of the manul is very long, soft, and abundant. Col. Prejevalsky states that the habits of this species are different from those of other cats, as it usually resides among rocks in bleak, exposed places, and seeks its food by chase rather than by stratagem. It does not climb trees or enter forests.

The common Jungle Cat (*F. chaus*) ranges over all Hindostan and Ceylon, and westward to Asia Minor, and is found on mountains to a height of eight thousand feet. It is of a more or less dark yellowish or reddish gray, with very few spots or stripes, and is rather larger than the common cat. The Flat-head Cat (*F. planiceps*) is dark brown, every hair tipped with white, giving the animal a silvery gray appearance. It has no dark spots, but the white of the under parts is marked with rufous brown. Its most remarkable character is the large size of the first premolars of both jaws. The first upper premolar is two-rooted, and its crown sometimes longer perpendicularly than that of the sectorial; and the corresponding lower tooth is as large. This, says Mivart, would accord with a fish-catching habit. It occurs in Malacca, Sumatra, and Borneo. The Bornean Bay Cat (*F. badia*) is also unicolor, and is bright chestnut above, becoming paler below.

The African cats, other than the lion, leopard, caracal, and cheetah, which are common to Asia and Africa, are only five in number, excluding two doubtful species. Of these the first to be mentioned is the Serval (*F. serval*). This is a rather large species, about forty inches in length from nose to tail. The legs are long, the tail is short (sixteen inches), and the color tawny, with black spots on the body, and black rings on the tail. Along the back the spots tend to run into two bands, and there are two black cross-bars across the inside of each fore-leg. The pupil contracts into an oblong; and there are two premolars in the upper jaw. It inhabits the whole length of Africa from north to south.

The west coast of Africa is the home of the Golden-haired Cat (*F. rutila*), which is known only from a skin and two other specimens. It is red-brown, with indistinct darker spots, and is about twenty-eight inches long. The Gray African Cat (*F. neglecta*) is a small species from the west coast of the dark continent, of gray color, with small dark spots on the back, and larger spots on the white of the belly. The Servaline Cat (*F. servalina*) is a third little-known West African cat of rather small size. The color is fulvous yellow, but the spots are arranged much as in *F. neglecta*.

Notwithstanding its name, the range of the Egyptian Cat (*F. caligata*), which was the one cherished by the ancient Egyptians, and is probably the main source from which the domestic cat was derived, extends throughout Africa and also into Asia, as it is said by Alston to occur in southern Persia and Palestine. The color varies from pale fulvous to gray, always with some more or less obscure stripes on the body, and some more distinct ones upon the limbs. The tail is ringed toward its tip, which is black. Varieties of this cat have received separate names at various times, and probably the *F. chaus* described from Africa is really this species. The hinder part of the feet are often black, as in the common cat and *F. torquata*, but this is not a constant character. Fossil remains of this species have been found in southern Europe.

In America we find a number of small cats. The first to be mentioned is the Ocelot (*F. pardalis*). Whatever the color of this cat it is always one of the most handsome of its tribe. The ground color varies from tawny yellow to reddish gray,

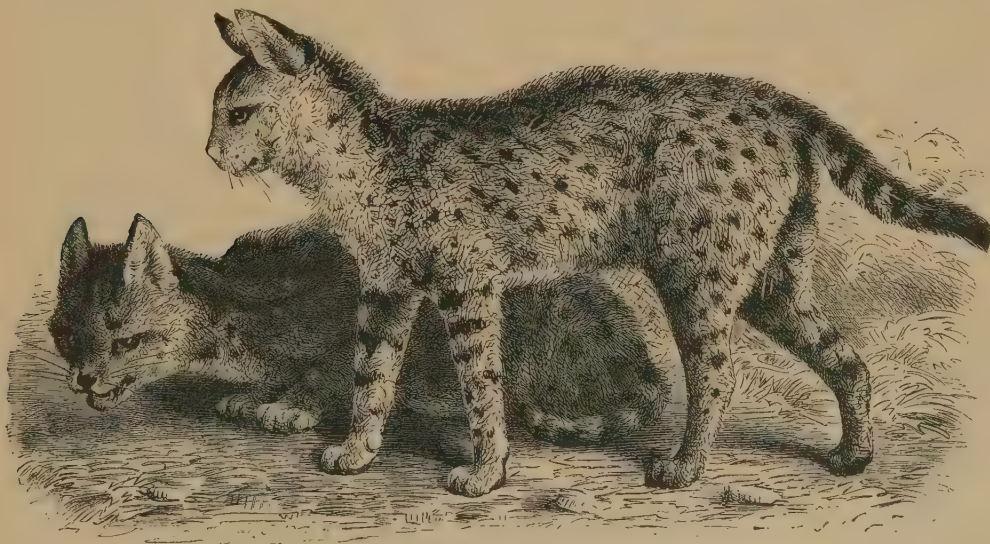


FIG. 216. — *Felis serval*, serval.

and the black spots which ornament the skin are gathered into elongated blotches that enclose an area darker than the rest of the ground. Small black spots are scattered over head and limbs, and there are two black stripes over each cheek, and one or two dark cross-bands inside each fore-leg. The under parts are whitish with roundish black spots, and the tail more or less ringed. In length the ocelot ranges from twenty-six to thirty-three inches, while its tail is about half the length of the head and body. A full-grown animal weighs upwards of twenty-five pounds. The varieties *F. grisea*, *F. melanura*, *F. picta*, *F. pardoides* are enumerated as species by Dr. Gray. The ocelot ranges northward through Mexico and the parts of the United States bordering upon it as far as Arkansas, and southward through tropical America as far as Patagonia. In Texas the ocelot extends eastward to the Rio Brazos, and northward to the hilly front of the first plateau region. It is by no means rare in that state. It is said to be an exceedingly bloodthirsty creature for its size, and is an agile climber.

The Margay (*F. tigrina*) is a rather smaller animal than the ocelot, ranging from twenty-four to twenty-seven inches in length, with a tail eleven to nineteen inches

long. It is an inhabitant of the warm lowlands and wooded regions of Mexico, and of all countries between Mexico and Paraguay. Three of Dr. Gray's species (*F. tigrina*, *F. mitis*, and *F. macroura*) are included under the *F. tigrina* of Mivart. The typical margay has rather harsh fur of a dull grizzled color varied with black spots and rings, while the other forms have soft fur of a bright fulvous tint, with black spots which often have a pale centre, and the tail is longer than in the typical form. Two nearly-related species, considered by Mivart to be distinct, are Geoffroy's Cat (*F. guigna*), and the Ocelot-like Cat (*F. pardinoides*). The first of these has short fur of a dusky whitish brown, with a white throat and a white streak on the cheek. There are four black streaks on the crown, two on the cheek, one between the withers, and several on the throat, chest, and inner and outer sides of the upper part of the legs, while the body is covered with numerous, evenly-distributed, small black spots of nearly equal size. The skull is short and broad, and the first upper premolar very small. It is a native of Paraguay and Chili. The ocelot-like cat is a native of the United States of Colombia, and measures only eighteen inches in length without



FIG. 217. — *Felis tigrina*, margay, long-tailed cat.

the tail, which is about ten inches long. It greatly resembles *F. guigna*, but the spots are much larger and form dark blotches with a black border.

The Yaguarondi (*F. yaguarondi*) is a form about the specific distinctness of which there can be no doubt. Like the puma it is unspotted, but it has a more elongated and slender body, and an exceedingly long tail. From nose to root of tail it measures about thirty inches, while the tail alone is twenty-five inches long. The color is blackish, brownish, or reddish gray, and examples of the various tints are found in the same locality. Each hair is ringed with black and gray. The pupil is said to be round, as in the puma and other large cats; the skull is elongated, flattened above, and remarkable for the manner in which the nose is pinched in laterally. The female is said to be usually of a lighter and brighter hue than the male. The yaguarondi inhabits Brazil, Guiana, and Paraguay, and extends northward through Mexico to its northern limit.

No other cat has so unmistakable a form as the Eyra (*F. eyra*), on account of the extreme length and slenderness of the body, and the shortness of the legs, especially of the fore-legs, characters which cause it to resemble a large weasel. It is of about

the size of the common cat, but with shorter legs, and is unspotted, of a uniform reddish yellow or chestnut tint, with a whitish spot on each side of the upper lip. The form of the pupil when contracted has been ascertained by Mr. Bartlett to be round. The skull, like the body, is much elongated, and is flattened on its upper surface; the nose is somewhat pinched in laterally, and the first upper premolar is present. An eyra in the London zoological gardens was very gentle, but another one was quite untameable. The range of this species is about the same as that of the yaguarondi; and it occurs in Texas near the Rio Grande. The hind-limb in the eyra exceeds the fore-limb in length by two-thirds the length of the latter.

The Colocollo (*F. colocollo*) is a little larger than the domestic cat, whitish gray, with elongated black marks on back and sides, and a black streak from the eye to the



FIG. 218. — *Felis borealis*, lynx.

jaw. As in the two last species, the skull is elongated and the muzzle produced. There is no first upper premolar. This species is known to inhabit Guiana and Chili, and doubtless occurs also in the intermediate countries.

According to Mivart, the Northern Lynx of the old world, and the varieties of the lynx that have been described from North America under the names of *Lynx canadensis*, *L. rufa*, and *L. maculata* should be ranged under one species (*Felis borealis*), since, after a careful examination of the rich series of skins at the British Museum, he can detect no constant difference, and, moreover, the skulls closely resemble each other. On the same subject Professor A. M. Edwards confesses his inability to decide. The old world lynx is reddish gray, more or less spotted in some examples, especially in the young. In the winter its fur is more gray, as well as longer and thicker than in summer; the fur of the cheeks is lengthened out to a variable extent, so as to form a pendent fringe; and the pads of the feet are more or less hairy. The Canada Lynx

(*F. canadensis*) resembles the European lynx very closely in color, but is usually smaller, not exceeding thirty inches from tip of nose to root of tail, with a tail five inches long, while the European form attains a length of forty inches without the tail. The Red Lynx (*F. rufa*), which ranges across the middle of the continent, and extends southward over Texas, has reddish hair that is shorter and less abundant than that of the Canada lynx; while the Spotted Lynx (*F. maculata*) has a handsomely spotted skin. The last is apparently only a southern form of the lynx, for every shade of transition between this long-haired spotted form and the more northern ones exists in skins from different localities. This variety extends southward to near the city of Mexico, and northward to the Rio Grande and southern California, and is thus the most southern form of *Felis borealis* with which naturalists are acquainted. North of the Rio Grande the form known as *F. rufa* becomes common, and extends through California and the United States alongside of the gray or typical Canada lynx, which not only inhabits Canada, but stretches across the continent to British Columbia and Alaska. The spotted variety appears to attain a larger size than the more northern American form. The old world variety inhabits not only Scandinavia and northern Russia, but northern Asia and some of the mountainous districts of central Europe, extending into Prussia. Mivart states that one was killed at Wurtemberg in 1846, and another in the department of the Haute Loire, France, in 1822. The lynxes of Asia Minor have many jet black spots on a beautiful silvery rufous ground, and on the thighs the spots show a tendency to form rosettes. The red lynx is stated to occasionally prey upon the skunk, spite of the strength and the powerful scent of that animal. Between the years 1769 and 1868 the Hudson's Bay Company sold 1,052,051 skins of lynxes.

The Pardine Lynx (*Felis pardina*) is the lynx of southern Europe, and differs from the northern form not only in color, but in the form of the skull, which is much more convex between the orbits than in any of the forms included under *F. borealis*. The upper parts of the body are rufous, the lower white, and there are numerous rounded black spots on body, limbs, and tail. It is a native of Turkey, Greece, Sicily, Sardinia, Spain, and Asia Minor, where its range overlaps that of *L. borealis*. The Thibet Lynx (*L. isabellina*), of a very pale yellow tint, is regarded as a doubtful species by Mivart. The Caracal (*L. caracal*) differs in several particulars from the other lynxes. It is more slender in form, has longer limbs, longer ears, and much longer tail; the skull is convex between the orbits, as in the pardine lynx; and the color is a uniform bright, fulvous brown, usually unspotted on all the upper parts, and paler or whitish below. Some individuals show traces of spots on the flanks, belly, and inner side of the limbs, and the tail has in all cases a black tip. It is the smallest of the lynxes, since it measures only twenty-six to thirty inches without the tail, which is nine or ten inches long. Its range extends throughout Africa, and thence eastward through Arabia, Persia, Thibet, and northwestern and central India to the east coast. Northward it passes into Asia Minor.

W. N. LOCKINGTON.

SUB-ORDER II.—PINNIPEDIA.

Semi-aquatic Carnivora, such as the otter and sea-otter, to some extent bridge over the gap which separates the land carnivores from the truly aquatic forms, and prepare us, by their webbed feet and other characters, to meet with a group like that of the

seals and walruses, with feet that have lost the power of supporting the body on land, and are fitted only to serve as fins for propulsion in water. There are between the seals and the Cetacea certain superficial resemblances that induced older naturalists to believe that the former mark the transition to the latter, but this idea is now generally abandoned, and, while the seals are on all hands allowed to be true carnivores, the whales are looked upon as probably derived from an ancestor akin to the Sirenia. The entire form of the Pinnipedia, or fin-footed mammals, is modified for life in water. The body is more or less fish-like, tapering at both extremities; the limbs are much shorter than those of ordinary mammals; the toes are united into a flat paddle, from which only the claws project; the tail is short, and the entire body is swathed with a more or less thick coating of fat. Their limbs, adapted for swimming and diving, are by their shortness and their envelopment to beyond the knees and elbows in the common integument of the body, incapacitated, except in a few species, from raising the bulky body from the ground, so that locomotion upon land is usually performed by the action of the ventral muscles, in a series of short jumps, or rather hitches, or by wriggling from side to side. In contrast to the Cetacea, the body is well covered with hair, and some have in addition a thick, soft, silky under-fur. The first digit of the fore-foot, and both the outer digits of the hind-foot are usually lengthened and enlarged.

Some of the principal points in which the skeleton differs from that of ordinary carnivores are: the constriction of the skull between the eyes, the large size of the orbits (all seals have very large eyes); the absence of a lachrymal or tear-canal in the lachrymal bone; the presence of vacuities between the palatine and frontal, and between the tympanic and exoccipital bones; the shortness of the ilium or hip bone, and the outward turn of its anterior border; and the usual separation, in the females, of the ischial elements of the pelvis. These barely meet for a short distance in the males.

The milk dentition is rudimentary, and frequently does not persist beyond foetal life. In the permanent dentition the number of incisors varies; the canines are always well developed, and in the walruses enormously so; and the premolars and molars usually differ from each other only in size, or in the number of their roots.

Existing pinnipeds may be divided into two principal groups, one containing the walrus and the eared seals, the second the ordinary seals. In the first of these the hind-legs can be turned forward and used in locomotion on land, and the anterior feet are nearly as large as the hinder. The toes of the fore-feet decrease from the first to the fifth, and have no distinct claws, while a broad cartilaginous border extends beyond the toes. In the hind-feet there are claws on the three middle toes only, and all the toes end in long, narrow, cartilaginous flaps, united at their bases. The hind-feet can be widely expanded.

The walruses, which form the Family *TRICHECHIDÆ*, can be readily distinguished from the other seals that are capable of using the hind-legs on land, by the pair of enormous, down-turned canines that project from the upper jaw, and by the absence of external ears. For the support of the huge tusks, the anterior part of the skull is greatly swollen, producing a facial aspect quite different from that of other pinnipeds. Most of the cutting-teeth of the second set fall out in early life, and the posterior molars are similarly caducous, so that an old walrus has in the upper jaw only a pair of incisors, a pair of large canine tusks, and three pairs of grinders; and in the lower no in-

cisors, a pair of canines, and four pairs of grinders. It is of course not known to what extent the extinct genera lost their teeth. The walruses have a thick and clumsy form, the neck is shorter than in the eared seals (*Otariidæ*), and the ribs, femur, and humerus are larger. All existing walruses belong to one genus, *Odobæus* of Linnæus, *Trichechus* of many later writers, but the two extinct genera *Alactherium* and *Trichecodon* appertain also to the family. Little is known of these two genera, but in the first the two halves of the lower jaw are not united by bony union, and meet by a long symphysis, while in the walrus the lower jaw is in early life firmly



FIG. 219. — *Odobæus rosmarus*, walrus.

united into a single bone, and the symphysis or line of union is short. The bones found (in Belgium) indicate an animal of larger size than the walrus.

There are two living species, *Odobæus rosmarus*, the Atlantic walrus, and *O. obesus*, the Pacific walrus. Old writers describe the Atlantic walrus as "as large as an ox and as thick as a hogshead," and though this description lacks definiteness, it gives a picture of an immense clumsy animal that is true to the life. The males are somewhat larger than the females, and a full-grown individual will measure more than twelve feet in length, and may weigh more than twenty-two hundred weight.

The length of the tusks varies greatly in both sexes, but those of the male are stronger, shorter, and stouter than those of the female, which may reach about sixteen

inches clear of the sockets. The head is rather small compared with the body, the muzzle abruptly truncated and somewhat bilobed, and the nostrils shaped and placed so as to somewhat resemble two commas set with their convex surfaces facing each other. The ear is marked only by an opening in a deep fold of skin; and the upper lip is heavily armed with strong, yellowish horn-colored bristles which, in the younger animals, are curved, and from four to six inches long, but appear to become shorter by wear. The body is thickest and deepest at the shoulders, giving the animal a majestic look when viewed in front. The fore-limb is free from the elbow, but the hind-limb is enclosed in the skin of the body nearly to the heel. The soles of all the feet are set with furrows and ridges, giving a firm hold on a smooth surface. Young and middle-aged individuals are rather thickly covered with yellowish brown, short hair, shorter below and on the limbs, where it darkens into a reddish brown. In old individuals the hair becomes more scanty, and bare patches appear, which become so large that very old examples are almost naked. The muzzle and its bristles are capable of great mobility, and the animal can retract its upper lip like a snarling dog. The walrus has no free tail like the seals and Otariidæ, for the caudal vertebræ are enclosed in a broad web of skin. The voice is a sound somewhat like *awuk*, between the mooing of a cow and the deepest baying of a mastiff.

The food of the walrus appears to consist in great part of mollusks, especially clams, which are dug from the sea-bottom by means of the tusks. Seaweed has also been found in its stomach. Most authorities agree that the tusks are used to aid the animal in landing on the ice and in climbing to the summit of icebergs and rocky islands, as well as for defence. The greatest enemy of the walrus, man excepted, seems to be the polar bear. Eskimo tales give the walrus the victory in personal conflict, asserting that he drowns the bear, but the latter is credited with acuteness sufficient to take up its position on a cliff above the walrus, and from thence to break its skull with a rock. It is greatly troubled with both external and internal parasites. It has as yet been found impossible to keep a walrus alive in captivity for any length of time. Young animals kept on board ship have shown much docility and intelligence.

The Atlantic walrus has been met with as far northward as man has penetrated, but the southern range has been greatly curtailed by the continued onslaughts of man. In the Old World it seldom visits the mainland, though it was abundant in olden times on the Norwegian coast, and it is becoming scarce in Spitzbergen and Novaya Zemlya. In the New World it still occurs on the coasts of Labrador, Hudson's Bay, Greenland, and the Arctic archipelago to the ninety-seventh meridian. Its usual eastern limit is not far beyond the Jenesei.

The walrus is at all times more or less gregarious, and frequents the neighborhood of shoals or large masses of floating ice. It is not regularly migratory, but moves from one part of the sea to another in search of food, and in May or June resorts to suitable shores to give birth to its young, at which period it will remain ashore for two weeks without feeding. The female is believed to go with young about nine months. A herd usually keeps a sentinel on guard. When at sea the whole herd will join in defence of a wounded comrade. In this way boats have been frequently staved in and upset, and Lamont states that in most seasons two or three lives are lost in the chase carried on around Spitzbergen.

In the chase harpoons are used, as with the whale, and are supplemented with lance, axe, and rifle. A well-appointed walrus-boat for five men is twenty-one feet long and five feet beam, and is bow-shaped at both ends. It is always painted white outside,

carries six harpoons, each with twelve to fifteen fathoms of line coiled separately in flat boxes under the front thwart, the end securely fastened. Four harpoon shafts about twelve feet long, four or five large lances, five boat-hooks, several axes and knives, an ice-anchor, lockers with smaller implements; some provisions as a precaution against emergencies, and some heavy rifles, complete the equipment. The harpooner is in command, and rows the bow oars.

The oil of the walrus is said to be inferior to that of the seals, and its quantity is smaller in proportion to the animal's size, since the largest seldom yield over five hundred pounds. The hide is valuable, and is principally exported to Russia and Sweden, where it is used to manufacture harness and sole-leather, and in the rigging of ships. The ivory afforded by the tusks is inferior to elephant ivory, and sooner becomes yellow by exposure. The flesh is sometimes used by Arctic voyagers, and is an important article of food with the Eskimos and Tchukchis. Fossil remains have been found at various points from Maine to South Carolina, and in Europe as far south as England and France.

The Pacific Walrus (*O. obesus*) is similar in habits, size, and contour of body to its Atlantic congener, but is possibly rather larger and thicker, and certainly has a much more uncouth appearance. The tusks are longer and thinner, and generally have a more decided inward curvature; the muzzle is deeper and broader, and the mystacial bristles shorter and smaller. The range of this species covers a smaller extent of both latitude and longitude than that of its congener. It has not been traced westward beyond Cape Schelatskoi (157° 30' E. long.), and has not been met with in large herds farther than Koljutschin Island (185° E. long.). On the American coast its farthest eastward point seems to be Point Barrow, where Beechey noted its presence in 1823. Southward none are now found beyond the Aleutian Islands, though Cook met with it to the south of Bristol Bay, and Russian writers report its existence in the last century on the Asiatic coast as far south as 58°.

Among the Prybilov or Seal Islands only Walrus Island is now frequented by this timid animal. It is exceedingly clumsy and slow in the water, when compared with the seals and eared seals, and on land is still more so. Mr. Elliott asserts that he never saw the tusks used in climbing out upon the ice, which is effected by the fore flippers only. Each immense beast would stay quietly at the edge of the water were he not literally forced onwards by the crowding of his companions. Their mode of keeping guard is this—when a walrus awakes he gives a blow with his tusks to his neighbor, who passes it on, and so on, so that some of the herd are always on the alert. No evidences of courage are given by the Pacific walrus. A large male measured by Elliott was twelve feet seven inches long from nose to tip of tail, fourteen around at the shoulders, and must have weighed at least a ton.

The Family OTARIIDÆ, or Eared Seals, can readily be distinguished from the preceding by the absence of tusks, the presence of small external ears, the slender elongated body and lengthened neck, and the smaller proportional size of the muzzle. The digits of the fore-feet decrease more rapidly from the first to the fifth than those of the walrus, and the first and fifth toes of the hind-feet have rudimentary nails. The pubic bones are not solidly joined by bone in the males, and are widely separated in the females. The milk teeth are, $i. \frac{3}{2}$, $c. \frac{1}{2}$, $m. \frac{3}{2}$; while the formula of the permanent dentition is, $i. \frac{3}{2}$, $c. \frac{1}{2}$, $m. \frac{5}{2}$ or $\frac{6}{2} = 34$ or 36. Swimming is performed principally with the fore-flippers.

The eared seals are by the character of their fur divided into the two groups of Hair Seals or Sea Lions, comprising *Otaria jubata*, *Eumetopias stelleri*, *Zalophus californianus*, *Zalophus lobatus*, and *Phocarcos hookeri*, and the Fur Seals or Sea Bears, including *Callorhinus ursinus*, *Arctocephalus falklandicus*, *A. antarcticus* and *A. forsteri*. The two groups of hair and fur seals have nearly the same geographical distribution, and usually frequent the same shores, but each species, as a rule, lives apart. They are equally distributed on both sides of the equator, but are almost entirely confined to temperate and colder latitudes, and none occur in the north Atlantic. The only unquestionable fossils of this group have been found in the Moa caves of New Zealand, and are referable to existing species.

The hair seals are larger than the fur seals, have coarse, hard, stiff hair, without under fur, and are usually of a yellowish or reddish brown color, darkest when young. There is considerable individual color variation, and great difference in size between the sexes. All are gregarious and polygamous, and all resort in great numbers to particular breeding-stations, known as "rookeries." The older males arrive first, select their stations, and fight for the acquisition and possession of the females. The strongest and most successful males thus acquire a harem of twelve to fifteen, or even more, and these they guard with the greatest jealousy, remaining on land during the whole of the breeding season, and fasting throughout the entire period. They arrive at the stations fat and vigorous, and leave weak and emaciated, having been nourished only by their own fat while on shore.

Otaria jubata, the Southern Sea Lion, occurs upon the west coast of South America, and is one of the largest of the group. There are six molars on each side of the upper jaw, or one more than in the northern sea lion. Other differences between the two are the far less proportional height of the skull at the orbits, and greater width of the posterior part of the skull in *Otaria*. The difference in size between the sexes seems to be greater in this species than in any other, the female skull having only three-fourths of the length, and less than two-thirds of the width of that of the male.

The Northern Sea Lion (*Eumetopias stelleri*) inhabits the North Pacific from Behring's Strait to California and Japan. The full-grown male measures thirteen and a half to fourteen feet from the tip of the nose to the end of the outstretched hind-feet, and from seven and a half to nine feet in girth at the chest, and has an average weight of one thousand pounds. Large individuals attain twelve hundred to thirteen hundred pounds. The females measure eight and a half to nine feet in length, and are more slender than the males. The young are of a rich dark chestnut brown, the adults light reddish brown. The ears are broader, but only half the length of those of the northern fur seal. This species is slightly larger than its southern ally, which it greatly resembles externally. The fancied resemblance to the lion is due rather to the heavy folds of skin upon the shoulders than to the slightly increased length of hair. From the accounts of various observers, the sea lions, probably on account of their greater size, do not move on land with the same facility as the fur seals. Although in their combats with each other as brave as the fur seal, the sea lion is an arrant coward before man. A child with a pop-gun, says Elliott, could stampede ten thousand huge bulls. Their voice is either a low growl or a deep grand roar, that harmonizes with the grandeur of the scenery around their abodes, which are often detached rocks lying near the shore, as at the celebrated Cliff House station close to San Francisco, and at numerous other spots along the rock-bound coast of northern California. The sea lion

is a most valuable animal to the Aleuts, who eat its flesh, burn the oil in their lamps, make thread from the sinews; convert the lining of the throat into boots, the soles of which are those of the animal's feet; make of the stomach an oil-bottle, and form the intestines, after tanning, into waterproof clothing. The Aleuts 'drive' the timorous creatures inland in parties of six or eight at a time, till some two or three hundred are assembled in the place of execution. A flag was formerly used to frighten them, but they are now scared, like the timorous tiger of the old story, by the opening and shutting of umbrellas. The driving must be done on a misty or rainy day, or after the dew has fallen at night, in order that the animals may be able to slip over the grass. The distance traversed in a day does not exceed six miles, so that three days or more may be spent before the village is reached. They are allowed to rest a day or two, and then killed by shooting.



FIG. 220. — *Eumetopias stelleri*, northern sea lion.

Zalophus has the same number of molars as the last genus, but has a much narrower skull, with a very high sagittal crest, and a much narrower muzzle. *Z. californianus*, the black sea-lion, is a common animal upon the coast of California, as far north as San Francisco. The great majority of the sea-lions at and near San Francisco, are of this species, but the larger *Eumetopias* occurs also. It is much smaller than the latter, since an adult male only measures from eight to nine feet in length. Its color is variable; individuals in the same rookery are reddish brown, dull gray, or almost black, with scattering hairs tipped with white. The young at birth are dark gray or slaty. Probably its range extends southward along the coast of Lower California. Captain Scammon states that this species resorts to artifice to capture the sea-gulls. The tip of its nose, just evident above the water, and made to move by the artful seal, tempts the hungry bird within reach of the well-armed jaws. *Z. lobatus* occurs upon the northern shores of Australia, and on the eastern coast of

Asia, from Japan southward. Of *Phocarcos hookeri* little is known except that it is a native of the Auckland Islands.

Of the fur seals the best known and most valuable to man is *Callorhinus ursinus*, the Sea-bear or Northern Fur Seal. In color this animal is nearly black, varying to gray upon the shoulders, and reddish brown below. The female is lighter in tint, and the young of both sexes are glossy black. The fine silky under-fur reaches nearly to the end of the coarser hair; and both are longest on the nape. The average weight of males of eight years of age and upwards is from four to five hundred pounds, and the length from six and a half to seven feet. The females are not more than one-sixth the weight of the males. As in the sea-lion, the dorsal vertebræ are fifteen, the lumbar five, but the sacral vertebræ are three instead of four. This species formerly extended southward along the coast of California, and Captain Scammon speaks of its occurrence at the San Benito Islands, on the coast of Lower California. It appears to be now rare along the entire northwestern coast of North America, and to be concentrated upon the celebrated Prybilov or Fur Seal Islands, the two largest of which, Saint Paul's and Saint George's, are its breeding-grounds. Sixteen and a half miles of sand-beach on the former, and two and a quarter on the latter, are occupied by the seals. They appear to inhabit also other islands to the northward and to occur along the coast of Kamtschatka and of Saghalien.

The fur seal steps with its fore-flippers as it moves up from the sea, carrying its neck erect, and its head fully three feet from the ground, but it brings up its rear by arching the spine, after each second step, and shifting its hind limbs forward sufficiently to enable it to take two more forward steps with the fore-feet before again dragging up the hind ones. During this leisurely march it holds its hind flippers out at right angles to its body, and supports its weight entirely on the heels. Each bull as he lands selects a position about ten feet square, and endeavors to hold it against all comers, thus, those who first land have to fight numerous battles, and are often driven higher up. In fighting they approach with averted heads and make many feints before they close, which they do by seizing each other with the teeth, and holding on until forced loose by sheer strength, thus tearing deep gutters in the skin and blubber. The cows are frequently very roughly handled in the course of the combats between the bulls, especially at the commencement of the season, when the bulls have all arrived, but the great body of cows have not. When the bull who has coaxed a cow to his seraglio springs into the water to coax another, a neighboring bull will pick up the timid and amiable little animal as a cat picks up a kitten, and then commences a series of battles, which may end in landing the cow three or four stations back from the beach. The bulls farthest from the water are thus usually constrained to maintain a smaller harem than those in front, and those at the extreme rear, who have come too late, may be compelled to celibacy.

The first bulls land in the beginning of May, and before the middle of June they have fought for and settled upon their stations. About this time the cows commence to appear, and at the end of the month arrive in great numbers. All are delivered of their young soon after landing, and are in heat a few hours afterwards. The cows spend much of their time in the water, but recognize their young by its cry, however it may be mingled with others. The cows do not bear until three years of age, and have but one pup. About the end of July the old bulls leave for the water, and remain absent for six or seven weeks, or altogether. By this time the family arrangements become indefinite, and by the middle of September the rookeries are entirely

broken up, though some may stay as late as the end of December or beginning of January. It is not known whether the sexes associate or not during the time they are absent from the breeding-grounds.

The yearling males and most of those under six years of age have their separate "hauling-grounds," placed to the rear or between the rookeries. It is these young seals that do all the fancy swimming, rising three or four feet from the sea, with back arched and flippers thrown back. With these are the young females, and the yearlings of the latter sex cannot be distinguished either by color or size from the yearling males.

The natives adopt with the fur-seal the same methods of chase as with the sea-lion, but leave the old bulls, whose fur is valueless. The Alaska Commercial Company has so limited the destruction of the seals on the Prybilov Islands that their numbers are not decreasing. Supply and consumption are made to balance, a result which, with equal care, might be effected with all animals and vegetables that are of use to man. About four million seven hundred thousand seals are estimated by Mr. Elliott to inhabit these islands, but after making due allowance for the number that perish at sea in early life, and for the perpetuation of the stock, not more than one hundred and eighty thousand young male seals can be taken for their skins.

Of the species of *Arctocephalus*, *A. australis* inhabits the Galapagos Islands, and the shores and islands of South America, from Chili to the Rio de la Plata; *A. antarcticus* is found in the coasts and islands around South Africa; and *A. forsteri* occurs in Australia, New Zealand, Saint Paul, and Amsterdam and some other islands. In this genus the facial part of the skull is narrower, longer, and much less convex, than in the northern fur seal, the nasals are longer, and the dentition is relatively stronger. The Hassler expedition (1872) found large rookeries of the first species at the Galapagos; but these southern sea-bears have been practically exterminated at many localities where they were once abundant. In early times sea-bears were found as far north as Cape San Roque, in Brazil, and even now a small rookery exists at Cape Corrientes.

Besides the backward turn of the hind-limbs, and lack of power in the limbs to support the body on land, the true seals (PHOCIDÆ) have a shorter neck than the eared seals; the first digit of the fore-foot is little, if any, longer than the others, and the digits of all the limbs are, as a rule, armed with strong terminal claws. The crest of the femur, known as the trochanter minor, which is well developed in the walrus, and eared seals, is absent; the pubic bones are approximated in the female; and the skull is without an alisphenoid canal. The incisors vary in number, from six above and four below to four above and two below, but the molars are always twenty in number.

In the first group of these seals the intermaxillaries are prolonged upwards till they meet the nasals, which are long, and there are always two incisors on each side of the lower jaw. To the genus *Phoca* five species are referred by Allen; *P. vitulina*, the harbor seal, which occurs on both sides of the Atlantic and North Pacific, and in the Mediterranean, extending southward to New Jersey and southern California on our shores; *P. groenlandica*, the harp seal, which also inhabits both oceans, but does not occur further south than Newfoundland; the *P. foetida*, the ringed seal, of similar distribution to the last; *P. caspica*, of the Caspian and Aral Seas, and *P. sibirica*, found in Lakes Baikal and Oron. Although these and other seals cannot progress in

the same manner as the sea-lions, many of them have been observed at times to change a wriggling motion for one in which the body is raised and the fore-flippers are struck upon the ground with force sufficient to drag the body along. After each blow of the flippers the body falls flat. In leisurely climbing the hind-limbs assist somewhat, and they are the chief agents in swimming.

P. vitulina is one of the smallest but best known species. It attains a total length of about five feet and a half, to the end of the tail, and a weight of eighty to one hundred pounds. In color it is very variable, ranging from uniform yellowish-brown to almost uniform dark-brown, or nearly black, and from dark spotting on a light ground to light spotting on a dark one, but brownish-yellow with darker spots is most common. The ringed seal is still smaller, and may always be recognized by the slight



FIG. 221. — *Phoca groenlandica*, harp or Greenland seal.

excess in length of the first digit of the fore-foot. The harbor seal is larger than the ringed, but smaller than the harp seal, and can be known also by the breadth and thickness of its molar teeth, and relatively larger head, more robust form, and shorter limbs. The actual length of the skull of an old male harbor seal exceeds that of a harp seal whose total length is one third greater. It is the habit of the harbor seal to ascend large rivers, often to a considerable distance above tide-water. It has been taken in Lake Champlain, and on the Columbia above the Cascades, two hundred miles from the sea. It is the only species at all common on the eastern coast of the United States. It never resorts to the ice-floes, but is confined to the shores, and does not associate with other species. This seal is sufficiently bold to take salmon from one end of a net while the fishermen haul in the other, and is capable of biting through the net with its strong teeth. The Leopard Seal, of California, is identical with *P. vitu-*

lina. It appears to be very fond of music, and certainly displays sufficient curiosity to follow the sound of a flute, or to crowd near to people bathing or passing in boats. The females show great affection for their young, which they take in their mouths or on their backs when danger approaches. The young are easily tamed, show great affection, and can be taught many accomplishments.

P. foetida, the Ringed Seal, is in length about equal to the last species, but is a much smaller animal. The adult is usually blackish brown above, shading into yellowish-white below, and the back is marked with large, oval, whitish spots. Others are mottled with blackish, and there is much variety in color. This seal is often mentioned by Arctic voyagers, and is the one which forms for itself an igloo, or domed cavity in the ice, and breaks for itself breathing-holes, or atluks. It is of the greatest importance to the Eskimo of Greenland and the Arctic archipelago, since it yields them both food and clothing.

The Harp, or Greenland Seal (*P. groenlandica*), is, when adult, of a whitish or yellowish-white. The males have the nose and head to behind the eyes black, while a crescentic black belt runs along each side and over the body at the shoulders and at the hinder part of the back. The young are pale gray, with dusky spots, and the harp, or saddle-shaped mark, does not become fully developed until the fifth year. The females are about one fourth smaller than the males.

This seal is eminently pelagic and roving in its habits, keeping near the edges of the drifting ice. It is gregarious, does not make breathing-holes, and is regarded as less sagacious than the other species of the arctic seas. Sword-fish and sharks are said to be great enemies of these seals, and Mr. Carroll states that he has seen the former press down the edge of a piece of ice on which a seal was floating, so that the poor animal was compelled to slip into the water. He even asserts that when sword-fish or sharks appear, a seal will run to a man for protection. The slaughter of these harmless creatures is often conducted with great barbarity, and as many as eight or nine hundred thousand are killed annually.

The Caspian Seal (*P. caspica*) is nearer to the ringed seal than to either of the other preceding species, but is rather larger, with smaller teeth and a more rounded cranium. It differs also from the ringed seal in its gregarious habits. The Baikal Seal (*P. sibirica*) is silvery-brown, unspotted, and has a longer and narrower muzzle than the ringed seal.

The Bearded Seal (*Erignathus barbatus*) differs from *Phoca* in the great height of the skull at the anterior border of the frontals, and in various other osteological characters. It is gray, darker along the middle of the back, but sometimes varied with black, or with indistinct light spots. Adult males are said to reach ten feet in length, and a female measured by Allen was seven feet two inches long. It is a native of the circumpolar regions, its presence as far south as Labrador is scarcely certain, and it does not occur on any part of the British Islands, though it inhabits Iceland, and the shores of Norway down to 62° N. lat. Its flesh is said to be more delicate in taste than that of any other species, while its skin is very thick. The teeth are like those of *Phoca*, but small; the molars are widely spread, and apt to disappear in old age.

The Ribbon Seal (*Histiophoca fasciata*) owes its erection into a genus to its conical double-rooted molars. The adult male is dark-brown, with a narrow, yellowish-white band around the neck, and another broader band of the same tint round the hinder part of the body. From the latter a belt runs along each side, joining its fellow on the shoulder. The adult female is of a uniform pale grayish-yellow, with an

obscure narrow transverse band across the lower portion of the back. In size it is about equal to the harp seal. Its habitat is the Kurile Islands and Okhotsk Sea to the island of Saghalien, and in America to the Aleutian Islands. The Gray Seal (*Halichoerus grypus*) has the same teeth as *Phoca*, but the proportions of the skull are reversed, since the facial part is long and broad, and the brain-case small. It is silvery gray, with obscure dusky spots; the whiskers are large and numerous; the first two toes of the fore-feet, and the outer toes of the hind-feet, are longest; and the length of an adult male is from eight to nine feet. The female is of lighter tint, and



FIG. 222. — *Cystophora cristata*, hooded seal.

does not exceed six and a half to seven feet in length. Its range is wholly confined to the North Atlantic; Sable Island, Nova Scotia, is its most southern limit in America; and it occurs on the coasts of Great Britain and Scandinavia, but seems to be absent from the islands of the Arctic Ocean. It is comparatively rare.

The West Indian Seal (*Monachus tropicalis*) has only four incisors above and four below. Its habitat appears to extend from the northern coast of Yucatan to the southern point of Florida, eastward to the Bahamas and Jamaica, and southward to about 12° N. lat. The only specimen in any museum seems to be an imperfect skin sent to the British Museum thirty years ago. Another species of *Monachus*, *M. albiventer*, is

the seal of the Mediterranean and Black Seas, extending in the Atlantic to Madeira and the Canary Islands, and possibly occurring also on the eastern coast of Africa.

The Hooded Seal (*Cystophora cristata*) differs in many respects from the species previously described. The nasal bones are very small, and the intermaxillaries are not prolonged to meet them. The supra-orbital processes are distinct, though small, and the incisors are reduced in number to four above and two below. A more conspicuous external character is the presence upon the top of the head of the male of a movable muscular bag, extending from the muzzle to about five inches behind the eyes. This sac is twelve inches long, and nine inches high when fully distended. The females appear to be entirely without this appendage. All the digits of both pairs of feet are armed with powerful claws. The color is bluish black, thickly dotted with lighter spots, and shading into a lighter tint below. The head and limbs are nearly uniform black. Occasionally the light grayish-white tint forms the ground, and the spots are darker. The



FIG. 223. — *Macrorhinus angustirostris*, sea elephant.

full-grown male is seven and a half to eight feet long, and weighs from eight hundred to nine hundred pounds; while the female scarcely reaches seven feet in length. The bones are very thick in proportion to their length, and are of a rather light, open structure. The usual range of this seal does not extend southward of Newfoundland on our own coast, and of southern Norway on the opposite side of the North Atlantic, to which, and to portions of the Arctic seas, it seems to be confined. Occasional examples appear, however, to have been taken on this coast as far south as New Jersey, and even as Chesapeake Bay, and upon the coasts of England and France. It is pelagic in its habits, and is not common anywhere. It is described as the most courageous of the phocids, often turning fiercely upon its pursuers. Moreover, it is difficult to kill the male either with a club or with seal-shot, on account of the protection afforded by the inflatable hood.

The Sea Elephant (*Macrorhinus angustirostris*) is the largest of the true seals, if not of all pinnipeds. There are probably two species of sea-elephant, one confined to

the coast of California and western Mexico, the other (*M. leonina*) found in Patagonia, Kerguelen Island, Heard's Island, and other parts of the southern seas. Scammon gives twelve to fourteen feet as the average length of the adult male, but states that the largest he measured was twenty feet from tip to tip. The length of the southern species is by various authors stated to be fourteen, twenty, twenty-five, and even thirty feet, and the circumference at eight, fifteen, and eighteen feet. There would appear to be, therefore, considerable individual variation. The proboscis of the male is about fifteen inches long when the creature is quiet, but elongates with excitement, which causes the ridges on its upper surface to disappear. The females have no proboscis, but the nose projects somewhat over the mouth. A large female does not measure more than ten feet from "tip to tip," and the bulk is not more than one-third of that of a large male. The young of both sexes have no proboscis, as was well seen in the five short-lived examples brought from Lower California to the Zoological gardens of Philadelphia in 1883. Capt. Scammon states that it formerly extended northwards to Point Keyes, 38° N. lat., but the incessant slaughter to which it was subjected has now made it exceedingly scarce in Lower California, and extinguished it in Upper California, unless it lingers at Santa Barbara Island. The southern species has also become scarce from the same cause.

Other phocids are *Ogmorhinus leptonyx*, a native of New Zealand, Lord Howe's Island, and Desolation Island; *Lobodon carcinophaga*, the Crab-eating Seal of the Antarctic seas; *Leptonyx weddelli*, specimens of which have been obtained upon the eastern coast of Patagonia; and *Ommatophoca rossi*, of which little appears to be known, save its occurrence in Antarctic seas.

Nineteen extinct species of phocids are enumerated by Allen from miocene and pliocene strata. All of these are European, and are nearly allied to existing species, especially to *Monachus albiventer* and *Phoca vitulina*. Mr. Allen does not consider that an unquestionably distinct fossil seal has yet been found in North America, although a form akin to *Lobodon* was described from a tooth which most probably was found in New Jersey.

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ORDER XII.—PRIMATES.

The Linnæan ordinal name *Primates* has, since it was first employed, undergone some changes in its signification. It included originally man, the monkeys, the lemur, and the bats, and claimed for these animals the highest rank in the mammalian series. The bats have been placed in an order by themselves. The superiority of man over the rest of the animal kingdom in respect to the development of his brain, as well, no doubt, as other considerations, induced Cuvier to form for his reception the separate order *Bimana*, the monkeys and lemurs being designated *Quadrumania* on account of the thumb-like nature of the innermost digit of the foot. From a purely anatomical point of view zoologists consider that this was a retrograde step, that Linnæus had properly formulated the position of man at the head of the *Primates*, and that if physiological and psychical characteristics are to be disregarded in the classification of other members of the animal kingdom this must also be done in the case of man. From these other standpoints the natural history of man will be fully dealt with in our sixth volume: here he will be treated simply as a zoological species, and as such he occupies the highest position in the order *Primates*.

After abstraction of the *Chiroptera* from the Linnæan order, the members of the group which remain share the following characteristics. In accordance with their arboreal life the clavicles have been retained, and the innermost digits of both hands and feet are opposable — that is, act as thumbs. The terminal joints are clothed with flat nails, rarely with claws. In the skull the orbits are always encircled by bone, and are generally more or less shut off from the temporal fossæ and directed forwards. The incisor teeth are typically $\frac{3}{2}$, although the lower forms exhibit frequent departures from this rule; the other kinds of teeth are present, and the permanent set are preceded by a milk set, as in all higher *Mammalia*. Except in the lower forms, where the cerebellum is not much covered, the hinder lobe of the brain is well developed. Two pectoral mammæ are always present, although to these an inguinal pair may be added, as in certain lemurs.

We propose to follow here the example of Professor St. George Mivart, who divides the *Primates* into two sub-orders, *Lemuroidea* and *Anthropoidea*; the first embracing the lemurs and aye-aye of Madagascar and their outlying congeners; the second including the marmosets, the monkeys of the Old and New World, and the different races of man. Various considerations have induced some zoologists to regard the lemurs and their allies as a distinct order, which generally receives the name *Prosimii*, and this separation certainly serves to express the opinion entertained by most anatomists that the earliest lemuroid animals may have given rise to other orders besides that of the *Primates*. It serves also to emphasize the fact that although living lemurs are extremely and sometimes grotesquely specialized, yet some of their characteristics recall peculiarities of the lower mammals. In the grade of evolution of the brain, too, the lemurs have made little advance towards the complication characteristic of the *Anthropoidea*, for the cerebellum is largely uncovered by the cerebrum. But the facts remain that when we attempt to formulate distinctions of ordinal value between the lemurs and their higher allies, we find that these reduce themselves to certain differences of skull and foot structure, which are not of such importance as those employed in the separation of the other mammalian orders.

SUB-ORDER I. — LEMUROIDEA.

Apart from the characteristics already referred to, the Lemuroidea differ in the following respects from the Anthropoidea. The orbits, instead of being shut off from the fossæ occupied by the temporal muscles, open freely into them; the innermost digits of the hands and feet are always of large size, and while the digits are for the most part provided with flat nails, the second one on the hand is always furnished with a claw.

The habits of the animals, and their geographical distribution, constitute a wider gap between them and the monkey than many of the peculiarities mentioned. One family is well represented on the African continent, and there are a few other outlying forms, but their stronghold is in the island of Madagascar, where they constitute the greater proportion of the mammalian fauna. According to Wallace sixty-five species of mammals have been described from this island, thirty-four of which are lemuroids, and as these include the largest forms they give a very remarkable facies to the fauna.

Most of the members of the group are nocturnal, and all are more at home in the trees of their native forests than on the ground. The coat is abundant and woolly, and very variable in coloring. In size they range from that of a fox down to a mouse, the smaller species being commoner.

Much difficulty has been experienced in securing specimens of different sorts of lemurs from Madagascar. This is not only a result of their nocturnal habits, but of the veneration which the Malagasy entertain at least for some of the species. They believe in the transmigration of souls to the extent at least that the babakoto and the aye-aye are treated with much respect, as new embodiments of their defunct relatives. The selection of the Latin name *lemur* for them is thus particularly appropriate, as the Romans also believed in the "*lemures*" or shades of the departed, and had a fixed day (*Lemuria*) set apart for appeasing them. Professor Haeckel uses the latter noun in a new sense as the name of a continent now largely submerged, which he supposes to have been the centre of distribution of the lemuroid ancestors of the higher orders of *Mammalia*, and part of which has persisted as Madagascar with its remarkable fauna. Palæontological discoveries have, however, shown that America can so far lay as good a claim to having been the original home of the lemuroids, for, as we shall see, not only do the earliest known remains of lemur-like animals come from American tertiary strata, but even forms have been found which assist the anatomist in bridging over the gap between the lemuroid and the anthropoid Primates.

Apart from two very singular and isolated forms, the spectral lemur and the aye-aye, all the species of the sub-order are united by naturalists in a single family, that of the *LEMURIDÆ*. One of the most singular features is the arrangement of the incisors and canines of the lower jaw, for the latter teeth, instead of forming projecting tusks, as they do in the upper jaw, range themselves closely beside the forwardly-directed incisors, with which they agree in shape. Unlike all the other digits, which are furnished with flat nails, the second digit of the hind-foot is provided with a longer or shorter claw. Of the digits, the fourth is the longest on both feet, although the difference in length is sometimes not much marked.

We shall describe the higher members of the group first, for certain peculiarities of the lower forms lead us directly to the aberrant species indicated above.

Three genera, *Lichanotus* or *Indris*, *Propithecus*, and *Microrhynchus* or *Avahis*, forming the sub-family Indrisinæ, are separated from the lemurs proper by the smaller number of teeth ($i.2, c.1, pm.2, m.3$), and by the disproportionate development of the hind-limbs. These form their chief locomotive organs, the anterior extremities being frequently held above the head in locomotion, although in the arboreal life, for which they are best adapted, the hands are just as well formed for grasping boughs as the feet. The thumbs of both are of very large size, and are very widely separable. Characterized by its comparatively great size, its extremely short tail, and rounded head, with little projecting snout, the Indri or Babakoto (*Lichanotus* or *Indris*



FIG. 224. — *Lichanotus brevicaudatus*, indri, babakoto.

brevicaudatus) is one of the most easily identified members of the family. The coat is extremely soft and woolly, and extends over the back of the hands and feet to the nails. The face, on the contrary, is almost naked, which circumstance, with the shape of the head, unites in producing an appearance more apelike than that of the other lemurs. It appears to be confined to the northwest of Madagascar, and according to the testimony of some travellers is trained by the natives to catch food for them, although this is hardly in accordance with the reports of others that it is looked upon with awe as a supernatural creature. The babakoto is extremely variable in coloring. The specimen figured is one of the departures from the commonest type, and was named *L. mitratus* by Professor Peters on account of the distinct white patch on the head which runs round the ears into a grayish-white ruff, adorning the throat. The

outer side of the fore and hind-legs and the flanks are also much paler than in the commoner variety. This diffusion of white coloration may further be so extensive as to involve all the coat; such varieties are known as Simpouné to the Malagasy, who regard them with an extra amount of veneration.

Differing from the foregoing chiefly in the possession of a tail, and in the smaller size of the hinder upper incisors, the species of *Propithecus*, *P. diadema*, *P. coronatus*, nevertheless resemble the Indris in their habits, while the short-nosed and short-eared Avahis (*Microhynchus laniger*) are more nocturnal and solitary creatures. The lemurs, in the narrower sense of the term, form the sub-family Lemurinae, and are confined in their habitat to Madagascar and the neighboring islands. They are distinguished from the foregoing group by the elongated muzzle, by the long and bushy tail, by the hind-limbs being similar in length to the fore, and by the dentition. The formula of the latter is typically $i.\frac{2}{2}$, $c.\frac{1}{1}$, $pm.\frac{3}{3}$, $m.\frac{3}{3}$, but the upper incisors in certain forms may be reduced in size with the premaxillary bone in which they are lodged. The pelage is extremely variable in coloring, and in many cases the sexes are totally different in this respect, so that, as in the case of *Lemur macaco*, the female was described for some time under a different specific name, *L. leucomystax*. In all, the fur forms a soft woolly coat of considerable thickness; in spite of this the animals appear to be extremely sensitive to cold, and curl themselves up when at rest, with the bushy tail disposed in such a way as to cover them as much as possible. Even in their native island it has been noticed that they take the opportunity of sunning themselves during the hot part of the day, stretching out the body in such a way as to expose as much as they can to the influence of the burning rays.

The habits of the various species appear to be very much alike; they live in troops in the densely wooded parts of the island, only rarely being found on open, rocky ground. In accordance with their nocturnal habits, they are to be hardly seen or heard during the day, but at night make the forest resound with their cries, which are quite out of proportion to their size, and in the case of *L. macaco* have been compared to the roar of a lion. In this respect they differ from the last sub-family, none of the members of which are possessed of such loud voices. Their chief food consists of dates and other fruits, and in a free state they appear to be dependent on juicy fruits for their water, as they are never seen to drink except after they have been in captivity for some time, and have grown accustomed to sweetened rice and similar substitutes for their natural food. Birds are frequently attacked, but the blood alone seems to be sought after. The young are brought forth almost naked, after a period of gestation of about four months, and are looked after very carefully by the mother, who clasps them against her breast with her limbs, and at first almost conceals them in her abundant fur. There are two pectoral mammae.

By far the greatest number of the species belong to the genus *Lemur*, in which the tail is at least half the length of the body, the face is more prolonged, and the upper incisors are present in the typical number. These are small and separated from each other and from the very strong canines by gaps, while the lower incisors and canines have the horizontal direction described above for the family.

Following Schlegel in his arrangement of the species, we find that the Ring-tailed Lemur (*L. catta*) is at once distinguished from its congeners by the alternate bands of white and black on its tail. It is somewhat smaller than the average size of the members of this genus, which is about forty inches inclusive of the tail.

The tail is uniform in all the other species, which may be distinguished, however,

by the ears and the coloring of the muzzle. In the Ruffed Lemur, *L. varius*, and the *L. macaco*, the ears are almost hidden below the long hair of the head. The former species owes its specific name to the distribution of black and white in the coat; the male of the latter is entirely black, and the female reddish-gray, with white whiskers. Of the species with longer ears, *L. mongoz* shares the same peculiarity of *L. macaco* as to the different coloring of the sexes; its muzzle is whitish in color, while *L. collaris* has a blackish-brown muzzle. The species mentioned are those met



FIG. 225. — *Lemur macaco*, lemur.

with most ordinarily in captivity, but the list of well authenticated species is by no means exhausted with them.

The two species which are ranged under *Hapalemur* are smaller than the foregoing, and have a much shorter muzzle. *H. griseus*, the type species, has a bushy tail of about the same length as the body (fifteen inches), and receives its specific name from the prevailing gray tints, which are darker and suffused with reddish hues on the upper parts. The dentition is somewhat peculiar; although the formula is the same as in the preceding section, the upper incisors are of very small size, and the hinder one

lodged inside the canine tooth so as not to be visible in a profile view of the skull. The reduction of the premaxillaries commenced here is carried further in the next genus, *Lepilemur*.

H. simus differs from the above in having a broader and more truncated nose, while its pelage is of reddish-gray color. We quote from Mr. Shaw some facts as to this species which he calls the Broad-nosed Lemur. "It comes from the higher level forests on the eastern side of the Belsileo, among the bamboos, on which it appears in a great measure to subsist. Its teeth are different from those of any other kind of lemur with which I am acquainted. It has the few sharp, outwardly inclined teeth in the lower jaw in the front, common to all lemurs, and which they use as scrapers and not to bite with. Besides these, nearly all its teeth are serrated cutting-teeth, and



FIG. 226. — *Stenops gracilis*, slender loris.

are arranged, not in opposition, but so as mutually to intersect. In this respect it is admirably accommodated to suit the country in which it lives, as with the greatest facility it can bite off the young shoots of the bamboo, and mince up a whole handful of grass blades and stalks at once, each bite cutting clean like a pair of scissors. Like very many grass-eating animals, it seems to feed nearly all day long. For several months I had this one chained on the lawn, and it scarcely ceased gathering the grass within its reach and eating it from morning till evening. It is also unlike other lemurs in its dislike of fruit. I have tempted it with very many different kinds of berries and fruits growing in the forest, but it would not touch any of them. It is very fond of cooked meat and also of sugar cane."

Besides the reduced size of the premaxillaries referred to above (there are no upper incisors), the genus *Lepilemur* is distinguished by its comparatively short tail. Thus in the type species *L. mustelinus* the body measures fourteen inches in length, the tail only ten. Its coat is reddish in color, with a tendency to become gray in the lower parts, but the throat is white and the tail brownish.

Unlike the other sub-families, the third, *Nycticebinæ*, is entirely unrepresented in Madagascar, being confined to certain parts of Asia and Africa. The foot structure is peculiar, in so far as the first digit on both fore and hind-limbs is turned back so as to adapt the creatures more completely for their arboreal life. So much does this interfere with their movements on terra firma that they are generally called "slow lemurs." The Asiatic species resemble the spectral lemur in so far as the eyes are of very large size, but the fore and hind-legs are nearly equal in length, and the tail is absent. They are ranged under the two genera, *Nycticebus* and *Stenops* or *Loris*. These are readily distinguished by their shape, for the former group are extremely clumsy, while the latter have slender limbs of much greater length. Both agree in the shortness of the index finger, a peculiarity which is exaggerated in their African allies.

The commonest species of *Nycticebus* are *N. tardigradus* and *N. javanicus*; the latter is confined to Java, but the former extends through Sumatra and Borneo to various parts of India. In their habits they appear to agree with the Slender Loris of Ceylon (*Stenops* or *Loris gracilis*), being nocturnal creatures, living upon small birds and insects when in their native woods. None of the Asiatic species exceed much a squirrel in size; the coat in all is of extremely fine and thick hair, often of brownish color. When at rest they huddle together for the sake of warmth, the slender loris especially coiling itself into most grotesque attitudes. There are only two pectoral mammae, and it is said that the young occasionally exceed the teats in number.

The African species are less ghost-like in respect to the size of their eyes; they agree with each other in the greater breadth of the hand and the reduction of the index finger, which is either rudimentary or in the form of a mere tubercle. Two genera are recognized, each of which includes but a single species. Of these the Potto or Aposoro of the west coast of Africa differs from the allied species in having a distinct although short tail, in the greater size of its hands and feet, and in the less rudimentary index finger. This species, *Perodicticus potto*, measures some eight inches, of which only two belong to the tail. The coat is of chestnut color, with a slight mixture of gray, pale on the lower parts. A few scattered whitish hairs cover the chin and muzzle, the latter of which is only moderately produced if we compare it with the lemurs proper. Mr. Skue records that the natives regard the aporoso with the same sort of awe as the Madagascar lemurs inspire. A specimen he had in captivity would not eat insects, milk, or bread, but was fed on pineapples and bananas. It slept all day, the mother perched on the top of the door of the room, with its young one clinging with both pairs of limbs close to the belly, but at night it became more active, and wandered all over the room in which it was kept.

Allied to the potto is the Angwántibo from Old Calabar. It is by some naturalists referred to the same genus, but the rudimentary character of the tail, the presence of extra cusps on the last molars, and of two shelf-like ridges which project from the pinna of the ear just above the auditory passage, appear to justify its separation as *Arctocebus calabarensis*. The coat is thick and woolly, of brownish hue, paling on the under parts, and nearly white on the throat. While the head is rounded in outline behind, it tapers rapidly in front of the eyes, forming a slender snout, from the point of which to the extremity of the tail the little animal only measures some ten inches. The tail is completely concealed by the fur, being only a quarter of an inch in length. A comparison of the hands with the feet elucidates the fact that although the limbs are nearly equally developed the feet are considerably larger than the hands. The innermost digits on both are opposable "thumbs," but the second fingers are most pecu-

liar, for that of the hand (index) is reduced to a mere wart, while that of the foot is furnished with a claw, forming a complete contrast to the flat nails of the other digits. Unlike the potto, the spines of the vertebrae of the neck do not project so as to be quite sub-cutaneous, although they may be readily felt through the skin.

The next sub-family, Galagininae, agrees in the dental formula with the foregoing, although the upper grinders have a characteristic oblique ridge. The most interesting osteological feature is the elongation of the proximal tarsal bones, the os calcis, and navicular, which is carried furthest in the African genus *Galago*, although present also



FIG. 227.—*Arctocebus calabarensis*, angwántibo.

in the Madagascar forms. The mammae are four in number, two being pectoral and two inguinal in position. The group is divided geographically in a most distinct manner, for the Madagascar genera, *Cheirogaleus* and *Microcebus*, do not extend beyond the island. To this sub-family belong the smallest lemuroid animals, many of them recalling rats and mice in form and size, although the long bushy tail detracts from the resemblance. We learn from M. Grandidier that all the Madagascan forms (which Professor Mivart prefers to unite under the genus *Cheirogaleus*) have the curious faculty of storing up round the tail and in different parts of the body a quantity of fat, which is gradually drawn upon during the six months of the dry season, when they conduct themselves entirely like hibernating animals in colder

climates. A very large number of nominal species have been described, for the *Cheirogalei* appear to be as variable as the other lemurs. The following descriptions relate to an example of each of the sections into which the genus has been divided, and are from the pen of Mr. G. A. Shaw, who captured them in central Madagascar.

"The Brown-mouse Lemur (*Cheirogaleus milii*), a small and highly-interesting animal, was caught in November, 1877, since which time it has lived in a small box, and has been allowed a little exercise about the room at night. It is nocturnal in its habits; and its food consists of fruits, and possibly honey. . . . The specimen is full-grown, about seven or eight inches in length, has a pointed snout and very prominent eyes, large ears, and round, rat-like tail, which is not prehensile. It is of a brownish gray color, approaching to white on the under parts. Its four legs are almost equal in length, thus rendering it difficult for this lemur to leap any considerable distance, as the majority of species can. It runs on all fours, but sits up to eat, holding its food in the fore-hands. I fancy that in the winter months in its natural state it hibernates, because in the beginning of last winter (that is in June), after several nights' good exercise, during which time it had the opportunity of eating as much banana as it chose to take, I was astonished in the evening on opening its box to find it still asleep, and quite cold to the touch. At first I thought it was dead; but by holding it near to a fire and rubbing it, it gradually awoke, and when thoroughly warmed appeared none the worse in health. This happened two or three times, and without any apparent cause, as there was no ill health, nor was the weather particularly cold. . . . It appears to be a very uncommon animal even in Madagascar, as this is the only specimen I have been able to obtain, although I kept a man in the forest for two months seeking for one after I had obtained this one. Of course, the fact of their sleeping all day and only feeding at night adds to the difficulty of catching them. It was easily tamed, and proved very affectionate; comes when called by name, and enjoys being rubbed.

"The Dwarf Lemur (*Microcebus smithii*) is another species of nocturnal animal, and the most diminutive lemur with which I have become acquainted. They live on the tops of the highest trees, choosing invariably the smallest branches, where they collect a quantity of dried leaves, and make what from below looks like a bird's nest. So close is the resemblance that it requires good eyes to distinguish the one from the other. Their food consists of fruit and insects, and most probably honey. I have frequently seen them catching the flies that have entered their cage for the honey, and I have supplied them with moths and butterflies, which they have devoured with avidity."

The African species are now retained by most authorities under the single genus *Galago*, while by others the larger forms, which have shorter ears and more pointed snouts are collected under the generic name *Otolemur*, the smaller forms under that of *Otolicnus*. One of the largest species is the Thick-tailed Galago, *G. crassicaudatus*, of which the body is twelve or thirteen inches long, and the tail over sixteen. According to Dr. Kirk it frequents the mangrove forests and wooded tracts outside them in Mozambique, remaining quiet in some shaded tree-top during the day, and displaying great activity at night when leaping from frond to frond, or from one tree to another. It is often reduced to captivity by its habit of robbing the pots used by the natives to collect palm wine, of which it is very fond, and frequently drinks to excess. In captivity it eats flesh, vegetables, fruit, and insects. *G. mahali* is common among the wooded hills of Kebrabassa, resting by day in the bush, but attracted to the camp-

fire at night. Its powers of leaping are as phenomenal as in the other species, six feet being readily cleared in single leaps which rapidly succeed each other.

Of the smaller species, *G. senegalensis* (*Otolicnus galago*) was the first described member of this section. It is of about the size of a squirrel, but the extreme development of the ears, tail, and tarsi, make the resemblance merely a superficial one. Its coat of reddish-gray hues on the upper, and whitish on the lower parts, is extremely thick and soft, as is the hairy covering of the end of the tail, which appears generally to be employed as a blanket during rest, for the galagos, like the lemurs proper, appear to be very sensitive to cold. This galago is pretty widely distributed in Africa, for besides Senegal, where it was discovered, it is likewise found in South Africa and the Soudan. All the galagos become rapidly tame and submit very willingly to being petted. We quote the following description of *G. demidoffii*, a species from old Calabar, from a communication by Mr. A. Murray:—

“It was a very epitome of zoology; of the size and color of a large rat, it had the tail of a squirrel, the facial outline of the fox, the membraneous ears of the bat, the eyes and somewhat of the manners of the owl in its cool, odd way of peering at objects; the long, slender fingers of a lean, old man, who habitually eats down his nails; and all the mirthfulness and agility of a diminutive monkey. It hated its cage at night, but delighted to leap among the bars of the chairs ranged purposely round the table for it. It could clear a horizontal distance of at least six feet at a leap; and whenever it fell, as during its short apprenticeship it often did, and from alarming heights too, it gave expression to its parenthetic chagrin by a rough sort of purring. It possessed a curious power of folding its membraneous ears back upon themselves, and somewhat corrugating them at pleasure; and it appeared to me that the palms of its hands, all four, were endowed in some degree with the power of suction, such as the walrus is said to possess in perfection. I have seen it maintain itself in positions where the mere lateral pressure of its limbs appeared to be inadequate for the purpose; and I once applied it to the side of a cylindrical glass shade, of which it could not embrace so much as a third of the circumference, and sure enough it maintained its position for some time, gradually sliding down until it gave way. The palm was very much depressed, always clean and glistening, surrounded by fine papilliform growths, those near the roots of the fingers serving as points of opposition to them, the fingers never closing beyond the palm.”

In respect to the power of suction referred to above, it may be noted that Mohricke has observed a similar power in several apes such as *Macacus speciosus* and *nemestrinus*, where soft cushions on the phalanges and palms are first hollowed and subsequently flattened out when the animal is walking on a vertical flat surface. Whether glands assist the action, as in *Hyrax*, is still uncertain.

A still smaller species is *G. murinus*; the body is never more than three or four inches long. Mr. Murray describes this species as readily tameable; it would run up his coat sleeve and nestle between his whisker and collar. Great dexterity was shown in pouncing on grasshoppers and even on the large mantides which it promptly devoured.

The galagos form a very natural transition to the second family, TARSIDÆ, for the remarkable little creature which we are now about to describe possesses, in an exaggerated degree, the elongation of the ankle-bones noted above. A single species is known—the Spectre, *Tarsius spectrum*, which owes its generic name to the peculiar

length of its tarsus, and its specific to its huge, round, yellowish-brown eyes. In its geographical distribution it is isolated from all the other members of the sub-order, being found in Sumatra, Banca, Borneo, and Celebes. In some respects *Tarsius* deserves to be considered as less modified from the primitive lemuroid type than the forms we have described above. The teeth, for example, are more like those of the Insectivora, but there are certain other features which exhibit a high grade of specialization. Such are the grotesque hands and feet, and the closure of the orbit behind from the fossa for the temporal muscle, a character which it shares with the higher sub-order Anthropoidea.



FIG. 228. — *Tarsius spectrum*, spectre.

The particular method in which adaptation to arboreal life has been secured in the *Tarsius* has brought about a remarkable resemblance to a tree-frog. Not only is there the round head, short neck, long hind-legs, and slender ankles, but the ends of the fingers and toes are provided with cushions resembling in structure those that we have met with in the galagos, but in form more like the suckers on the tree-frog's toes. The body is thus admirably formed for leaping from branch to branch, the tail, which is longer than the body, and only hairy at the tip, projecting straight backwards during its leap. The body measures some six or seven inches in length, and is clothed with a thick coat of yellowish gray hue, slightly suffused above with reddish brown tones, while the under parts are pale. From the wrist and ankle to the tips of the fingers and toes the hairs are short and scanty, as is the case also on the short ears and nose. It is interesting to note that the incisors are not procumbent as in the lemur proper,

and that the molars are provided with numerous cusps, in accordance with the insectivorous habits of the creature. The teeth are arranged according to the formula $i.\frac{1}{2}, c.\frac{1}{2}, pm.\frac{3}{3}, m.\frac{3}{3}$. A further peculiarity of the species is the fact that the third digit of the anterior, and the fourth of the posterior extremity are the longest. The second and third of the hind-foot bear claws instead of nails. Only one young appears to be usual at a birth, although the teats are the same in number and position as in the galagos.

In its nocturnal habits the spectral lemur resembles its allies. According to Cumming it is not common, only occurring in the thickest bush, where it lives in pairs in the hollow roots of bamboo trees. Insects are not its only food, for small lizards are attacked with greater relish when they are to be had. It is readily tamed, and shows considerable affection after a while, although when first caught it snarls, especially if approached when resting during the day.

With the last family of the Lemuroidea we return to their headquarters, Madagascar, to study one of the most singular forms of Mammalia, which has excited the curiosity of naturalists since its first discovery rather more than a century ago. The CHIROMYIDÆ include only the singular Aye-Aye (*Chiromys madagascarensis*) which on account of its singular dentition, was once referred to the rodents, as in these animals the incisors are possessed of growing roots, and are faced with enamel. The canines and premolars which succeed these in the jaw in the milk dentition are hardly represented in the adult, so that the formula stands $i.\frac{1}{2}, c.\frac{0}{0}, pm.\frac{1}{1}, m.\frac{3}{3}$. The fingers and toes are free and of great length, especially the fourth; all except the innermost are provided with claws, but the greatest peculiarity is the extremely slender third finger, which alone would serve to mark out the aye-aye as a creature by itself.

An adult aye-aye measures some forty inches in length, of which half belong to the tail. The large membraneous ears give it some resemblance to the galagos, but the character of the coat is very different from that of the lemurs generally. In addition to the grayish woolly covering there are also coarse brownish-black hairs, which, as they project further, give to the coat a very sombre hue, only interrupted here and there by gray hairs. The bristles in the neighborhood of the mouth are of considerable strength, as are those of the tail. Unlike the other members of the sub-order the aye-aye has only inguinal teats, which are present in one pair.



FIG. 229. — *Chiromys madagascarensis*, aye-aye.

In captivity the aye-aye has been frequently observed in Madagascar but very rarely in European zoological gardens. Its intellectual faculties are by no means well developed, and it has not been noticed to show any affection for its keeper, such as is common among many Lemuridæ.

One of the most recent accounts of the natural history of the aye-aye is that of Mr. Baron, from which we condense the following:—The aye-aye lives in a restricted portion of the dense forests near the eastern border of the central plateau. It is apparently rather common, but its nocturnal habits, and certain superstitions of the natives, account for its apparent rarity. The native name for it is hai-hay (hihi), “but this is not derived from the ‘exclamations of surprise’ which the natives ‘exhibited at the sight of an unknown animal,’ but is simply onomatopoeic, the creature’s call being ‘hai-hay.’” It builds a nest, about two feet in diameter, of twigs and dried leaves in the dense foliage, with an entrance on the side.

With its teeth it scratches away the bark of trees in its search for insects, and the long claws are used in extracting its food when found. It does not flee at the sight of man, because for generations it has not been molested by him. The natives have a belief that it possesses some supernatural power by which it can destroy those who seek its harm, and to this it owes its immunity. This also explains the difficulty of obtaining specimens. When taken accidentally in a trap, occasionally one of the more daring spirits who is versed in aye-aye mystery, knowing the charm to deprive it of its mystic power, smears it over with fat, thus securing its forgiveness, and brings it to market. “The story goes that occasionally when a person sleeps in the forest the aye-aye brings a pillow for him; if a pillow for the head, the person will be rich; if for the feet, he will shortly succumb to the creature’s fatal power, or at least will become bewitched.”

Mr. Baron’s interesting description is modified in some respects and supplemented by a communication from Mr. Shaw. He regards it as unquestionable that the name is merely the equivalent of the Malagasy exclamation of surprise. A specimen which he had in captivity refused to eat honey in any form, but was very fond of bananas. These it eat in a very clumsy fashion, getting its mouth clogged in such a manner as to forbid the notion of large fruits forming its staple food. It eat of small fruit, of a variety of shrubs, and of sweetened rice, but would not touch meat, insects or their larvæ, or birds’ eggs. The hands were employed in steadying the animal in the bottom of the cage, and invariably after feeding the long, slender finger was drawn through the mouth. The creature possesses the power of separating the lower incisors as far as the gum, and bit in this way the wires of the cage.

From the anatomical standpoint we have seen that the Lemuroidea share many peculiarities of the lower Mammalia. An interesting confirmation of the position we thus accord them at the base of the Primates is afforded by their occurrence and distribution in past geological time. Only within the last decade have undoubted lemuroid remains been found in eocene strata, while it is not till the miocene period that any of the higher Primates have been detected. Professor Marsh has described two families with lemuroid affinities from the lower eocene of Wyoming, the LIMNOTHERIDÆ and LEMURAVIDÆ, both of them more generalized as far as their tooth-structure goes than the existing lemurs. In French eocene strata a lemur allied to the potto has been found, and in Switzerland another form which appears to have some of the peculiarities of the New World monkeys. Professor Cope has described from miocene strata, *Menotherium*, allied to the former family; but his most interesting

find is unquestionably the *Anaptomorphus homunculus* from the lower eocene of Wyoming. This species was about the size of a marmoset, had but two premolars in the upper jaw like the Indrisinæ, but these were two-lobed as in some of the higher Primates. As far as dental characters go, *Anaptomorphus* comes closer to man than any of the existing Primates. The incisors are erect, the canines small, and there are no gaps between the teeth such as exist in the lemurs. The cerebral hemispheres are large for an eocene mammal, extending to between the middle of the orbits, which are partially walled off from the temporal fossæ.

We shall have an opportunity to recur to the problem suggested by the geographical distribution of the lemurs in past and present time, after we have discussed the higher Primates from the same points of view.

SUB-ORDER II. — ANTHROPOIDEA.

The term Anthropoidea, which means man-like, is applied to the highest group of the primates, in contradistinction to the group which we have just left. The posterior lobe of the cerebrum is much developed, the orbits are separated from the temporal fossæ by a bony partition, and the two mammæ are always pectoral in position.

In point of size and intellectual development the marmosets form unquestionably the lowest group of the Anthropoidea. Naturalists differ as to the precise zoological value of the group. By some they are regarded as a division co-ordinate in value with all the New World apes on the one hand, and the Old World apes on the other. By others their affinities with the remaining apes of the New World are recognized, and they are merely regarded as forming a single family of them. The word marmoset is derived from the French, and implies that these monkeys are more squirrel-like or marmot-like in their appearance and their habits than the rest of the sub-order. There is much in their attitude, their manner of climbing, and especially in their size and the nature of the coat to suggest affinities to these rodents, but the resemblances are merely superficial. Geoffroy St. Hilaire formed for them the separate division Arctopithecii (*i. e.*, marmot-like apes) in view of this superficial resemblance, but the family is frequently known as HAPALIDÆ, from the principal genus *Hapale*.

The Hapalidæ are confined to northern South America. Brazil may be regarded as their headquarters, but they extend to the Pacific coast in Ecuador and New Granada, and even into Panama, where they find their northerly limits.

As already suggested, the marmosets are the smallest of the monkey tribe. The body may vary from seven inches to a foot in length, the tail equalling or exceeding the length of the body. The pelage is thick, and often in some species of extremely soft and almost silky texture. The creatures appear to be extremely sensitive to cold, and are consequently difficult to keep in northern climates, but their abundant furry coat, aided by the bushy tails, which are not prehensile, as is the case in many other monkeys of the New World, would appear to be sufficient for their protection in their native forests. Variation in color is extremely common in some species, and thus a number of nominal species have been created. The length of the hair may be different in different places; thus we shall meet with some species having long, fringed ears, others with abundant whiskers, and others again with a formidable lion-like mane. Of the extremities, the hind-limbs are decidedly the more powerful. They also deserve to be called hands, from a physiological point of view, more than feet, because they alone

have the inner digit (the great toe or hallux) opposable to the others, while the innermost digit of the anterior extremity (the thumb) is not capable of being opposed to the others, from the want of the proper muscle for that purpose. In comparison with the other digits of the hand, the thumb has about the same relative length as in man, reaching about as far as the joint between the first and second phalanges of the index finger. The hallux, on the other hand, is comparatively much shorter. It alone bears a nail; all the other digits, even the thumbs, are armed with long claws, and the bones of the last joints of the digits are modified in accordance with this peculiarity.

In the absence of the power of prehension from the tail and the anterior extremities, these long claws prove of great service in climbing. Bates, in the account of his travels on the Amazon, describes the use of these in making progress up and round large cylindrical tree-trunks and branches. The marmosets do not venture to such slender branches as some members of the next family do, nor do they indulge in such apparently venturesome leaps, but their movements are extremely active and squirrel-like.

Although from a psychological point of view the marmosets occupy by no means a high place among the Mammalia, yet the hemispheres of the brain are of considerable size, and project backwards so as to conceal the cerebellum. Their inferiority is indicated by the smoothness of the cerebral surface. The rounded shape and smooth character of the skull thus give it a certain resemblance to the Old World apes, — a resemblance which is heightened by the circumstance that the teeth are the same in number, thirty-two. Their formula is, however, different ($i.\frac{2}{2}$, $c.\frac{1}{1}$, $pm.\frac{3}{3}$, $m.\frac{2}{2}$), for there is one extra premolar, and one true molar the less. Thus, as far as the number of the premolars go, they agree with the other apes of the New World, but unlike them have two instead of three molars on each side in each jaw. An inspection of the crowns of all the grinders shows a further character of the marmosets which separates them widely from other monkeys. The surface, instead of being armed with blunt cusps, rather reminds one of the sharp-pointed projections on the molars of the Insectivora. It is now well known that the marmosets are largely insectivorous; although they may be fed for some time on sweet fruits like the banana, yet when in confinement they only prosper if they are allowed a certain amount of animal food to replace the absent elements of their diet. Bates observes that those in captivity in Pará took the opportunity of helping themselves to soft-bodied spiders and grasshoppers whenever they could, and Audouin found that a marmoset recognized with great promptitude the figures of insects in a work on natural history.

The incisor teeth present some important points of difference in two sections of the group. Although some naturalists are inclined to unite all the species of marmoset under the single genus *Hapale*, yet ordinarily two genera are recognized, *Hapale* and *Midas*, the further subdivision of the late Dr. Gray not being generally accepted. In *Hapale* the lower incisors are slender and linear, of similar size to the canines, and arranged with them in a curved line with a forward projection somewhat similar to that in the lemurs. But in *Midas* the cutting teeth are short and truncated, arranged in a straight line, and the canines are much larger, conical in form, and projecting from the mouth.

Some of the species are not uncommonly found in menageries, where their lively movements attract attention. Their expression indicates more intelligence than is possessed by the creatures, for in this respect they are only little more gifted than the lemurs. Humboldt states that they are generally secured alive either by trapping

them in a baited basket, or by using weakly poisoned arrows from the wounds of which they recover. The young are frequently secured with the mother, to which they adhere with great tenacity. Two or even three are brought forth at a birth after a period of gestation of only three months. Only one is suckled at a time, the others being tucked away among the longest hairs of the coat, or given in charge to the male to be tended. Several of the forms have bred in captivity, but their sensitiveness to change of climate rarely suffers them to be retained in robust condition. They seize on fragments of wool, and anything that may contribute to keep their nest warm. Brehm considers that as long as proper food is supplied to them they are sufficiently hardy, and records an observation of Reichenbach's to the effect that he succeeded in restoring to life one which had almost been frozen stiff with cold.

The White-eared Marmoset, *Hapale aurita*, is of blackish hue, marked with yellow or reddish points, and its tail, as is the case with most of the species, is distinctly annulated. The ears are large and naked, except for a tuft of gray hairs which rise from the inner surface of the conch, and resemble in color a spot on the forehead. Variations are not uncommon, for the back is frequently reddish, with narrow, faint bands across the loins. A second allied species, *H. humeralifer*, has much white in the fore part of the body, while the remainder is brown and white, grizzled.

Allied to the above is *H. chrysoleucos*, secured near Barba, and described as white in color, with hands and tail of a brilliant ruddy hue, and with white pencilled ears. Bates met with several of this species near Cametá sporting about like little white kittens among the branches of a cacao grove. He supposed it to be the *H. argentatus*, the albino variety of *H. melanurus*, to be afterwards referred to, but its pencilled ears immediately distinguish it from that species. The face is nearly naked, the hair extremely silky, and the length of the whole body not more than seven inches. They are regarded as great pets, and Bates could not induce a woman whom he met carrying one to part with it on any consideration. It appeared to be as timid and distrustful of strangers as any of the other members of the family.

The Black-eared Marmoset, *H. jacchus*, differs from the foregoing species in the position of the ear tuft, which occupies the front edge of the ear opening. The hair of the sides of the crown is long, the tail ringed with black, and the back and outside of the thighs cross-banded with gray. A white spot marks the upper part of the nose. This species appears to vary much in the proportion of white on the face, and a number of nominal species have been formed of such varieties. Such are *H. penicillata*, in which the ear tufts are black as well as the head, *H. vulgaris*, in which the tufts are white and the head black, *H. leucocephala*, where the tufts are black and face white. Two of these varieties, *H. vulgaris* and *H. penicillata*, are figured, beside the albino variety of *H. melanurus* referred to below. Of all the marmosets that are exported from their native forests the varieties of this species, often named Sagouins or Ouistiti, appear to be the hardiest, and are consequently more frequently met with in menageries than the other species.

One of the smallest forms is the Pigmy Marmoset, *H. pigmæus*. Bates met with this species at St. Paolo. The body measures seven inches; the ears are slightly hairy, but there are no tufts. Brownish tawny hues prevail on the trunk, but the tail is barred with black, and the face is provided with long, brown whiskers, which are brushed back over the ears. It is confined to Brazil, although by mistake its range has been said to extend to Mexico.

H. melanurus receives its specific name from its black tail, the color of which even persists in the albino variety, *H. argenteus*. It extends from Brazil into Bolivia, and, as noted above, is characterized by the naked ears which are large and exposed. The ordinary hues are ashy brown, darker on the head and limbs, and paler on the chest, while the front of the thighs and a band across the loins are whitish. A larger species has been described from Antioquia in Colombia which has received the specific name *H. leucopus* on account of the white forearms, hands, and feet. It agrees with



FIG. 230.—1. *Hapale vulgaris*. 2. *H. argentea*. 3. *H. penicillata*, marmosets, sagouins.

the foregoing in having naked ears, but has a white tip to the black tail. The body measures between eleven and twelve inches in length, and the tail between fourteen and fifteen.

As many as twenty-four species of *Midas* have been described, some of which are possibly nominal. Of these the Marikina, *M. rosalia*, from the Upper Amazon is certainly one of the most distinct. With another species, *M. chrysomelas*, it shares a remarkable development of the hair of the head, which is brushed backwards from above the forehead, and forms a conspicuous ruff all round the neck, which is longest on the nape, forming a lion-like mane. The marikina is of a golden yellow or reddish

hue, while the allied form is almost entirely black, and is possibly only a melanism of the other. In both the hair is of very soft and silky texture. Bates observed a marikina on the upper Amazon in captivity which was extremely active and playful, displaying much curiosity, and running over the persons of visitors to its owner without any of the shyness or distrust so frequently seen in these forms. In size it is one of the smallest of the genus, the body only attaining a length of seven inches.

Like the foregoing species in the possession of long hair on the head, but differing in its arrangement, the Pinche, *M. oedipus*, is a somewhat more northerly form. It extends into Colombia, and specimens are sometimes exported thence as Titi monkeys, the name reproducing the chirping voice, which, however, is not confined to this marmoset. The crown bears a thick patch of long, white hair, which looks as if brushed straight backwards, falls down at either side behind the ears, and gives the little creature a somewhat venerable aspect. The pinche is little larger than the marikina; its general color is grayish brown, reddening on the outside of the limbs and at the base of the tail, but giving place to white on the under parts as well as on the fore-limbs and the front edge of the hind-limbs.

The most northerly form of this family is Geoffroy's Marmoset (*Midas geoffroyi*). It occurs abundantly in the forests of New Granada near the coast, but also extends up as far as Chiriqui near the boundaries of Panama and Costa Rica. Like the pinche the face and sides of the head are somewhat naked, but the hair on the crown is comparatively short and not elongated into a tuft as in that form. The general color of the upper parts is grayish brown, of the lower parts whitish, but the pure white vertex, the deep chestnut coloring of the nape and back of the neck, as well as of the base of the tail, which however becomes black towards the extremity, form the diagnostic character of the species.

The remaining species of *Midas* are destitute of the long hair of the head characteristic of the foregoing. Some of them, *M. ursulus* and *bicolor*, have no white on the lips, and may be readily distinguished by this negative feature. *M. ursulus*, the Tamarin, is described by Bates as the first marmoset met with in the neighborhood of Pará, being apparently less afraid of man than the other species, and occasionally penetrating into the gardens of the town. They occur in little groups of three or four, are very often kept in captivity by the inhabitants, when they become readily tamed, although at first querulous and irritable and distrustful of strangers. The tamarin further differs from the species already described in the greater proportionate length of the tail, which is also decidedly bushier. Of the twenty-four inches which the creature measures fifteen belong to the tail. The general color is black, dashed with grayish or reddish brown, and the hands are also black, although a variety (*rufimanus*) is described in which these are golden yellow.

The species *M. bicolor*, sharing the absence of white on the nose and lips with the above, differs from it in general color, which is grayish brown. White prevails on the fore parts, but the tail is black on the upper surface. The head is naked in front, while behind it is covered with short white hairs.

Numerous species are described which, unlike the foregoing, have more or less white on the lips, as also on the nose. Bates describes one of these as looking, at some little distance, as if it had a ball of cotton in its mouth. Their specific names are generally indicative of some easily-recognized feature; thus *M. mystax* from Peru and the Upper Amazon has long, white hair on the nose and upper and lower lips, which give it a moustached appearance. In *M. labiatus*, from the north side of the Amazon

the white moustache is less conspicuous, and the belly is red instead of black. *M. pileatus*, a black variety of the above, has a golden yellow cap. *M. rufiventer* has more red on the under parts than *M. labiatus*, and a characteristic triangular golden or rufous spot on the crown of the head and nape. *M. leucogenys*, again, may be distinguished by a large triangular white spot under each cheek, while *M. flavifrons* has the top of the head yellowish brown. Other described species are *M. devillii* from Peru and *M. illigeri* from Colombia.

It is singular that these species have often a very limited range, one giving place suddenly to another, and perhaps only separated from it by a river or some similar barrier. It is probable that some of the species are only color races. Bates gives expression to this opinion in regard to *M. rufoniger*, which, on the upper Amazon, replaces *M. ursulus*, and may perhaps be a rufous variety of that species.

The remaining monkeys of the New World have been designated Platyrrhini, in reference to the broad septum which separates the nostrils widely from each other, causing them to look outwards instead of downwards, as in the case of the Old World apes. The family, however, is very generally known as that of the CEBIDÆ, from a very characteristic member of the group.

No character peculiar to the family is furnished by the hair in this group, for it may be harsh or silky, long or short, in different genera. The brilliantly colored naked callosities, however, which are so characteristic of the Old World apes, are here absent. Valuable specific characters are afforded by the color of the coat, as well as the length and direction of the hair on certain parts. The bony external auditory passage is deficient in the Cebidæ, and Mr. Forbes has pointed out that the skull of a New World monkey may be further distinguished from one of the Old World forms by the fact that the parietal and malar bones meet on the side walls. The shape of the skull, and the relative length of the limbs, vary much throughout the group, the former being naturally influenced by the shape and development of the brain, which Professor Flower finds subjected to much wider modifications than is the case with the apes of the Old World. All of the members agree, however, in the dental formula, which is $i.\frac{2}{2}, c.\frac{1}{1}, pm.\frac{3}{3}, m.\frac{3}{3}$. The Cebidæ have thus one true molar on each side in each jaw more than the Hapalidæ, and one premolar more than the Old World forms.

Certain species have shelving incisors, such as we have met with in the lemurs, but as a rule these teeth are erect. As we shall see in the next family, there is occasionally a greater or less tendency to the disappearance of the thumb: this is most marked in the Spider-monkeys. In no case is the thumb opposable, or armed with a flat nail, in the same way that the great toe is. The relative length of body and tail is subject to wide modifications, for the tail is often longer than the body, and in a few cases very short, although not so much so as in some Old World apes. Characteristic for many members of the family is the prehensile nature of the tail, which may be naked under the tip, and so extremely sensitive as really to form a fifth hand. As the New World apes are midway in size between the Hapalidæ and the Old World forms, so we find that the average period of gestation, six months, is also intermediate in duration.

We shall adopt the arrangement of the sub-families proposed by Professor Mivart. The first of these (Nyctipithecinae) includes certain forms of small size, in which the tail is not at all prehensile, and which agree with the marmosets in the nature of their food, insects and small birds being hunted by them, and, as well as fruit, forming an

important part of their diet. It might, perhaps, be more in accordance with the anatomical features to keep the genus *Nyctipithecus* by itself, but the genera *Chrysothrix* and *Callithrix* certainly share with it the distinction of being the least specialized, in the direction which may be regarded as most characteristic of the apes of the New World.

Bates met with two species of *Nyctipithecus* in his travels on the Amazon, *N. trivirgatus* and *N. felinus*, or *commersonii*. In the Tupi language they are spoken of as Ei-á, but they are also known as the Durukuli and Vitoé, respectively. The two species are found side by side without intercrossing, living in the forests of the higher and drier lands. As their generic name indicates, they are strictly nocturnal creatures, sleeping all day long in the hollows of trees, not sufficiently soundly, however, not to be disturbed by the casual passer-by, and emerging at night to secure their food, which consists of various fruits and insects. Like the lemurs, which they resemble in their nocturnal habits, the fur is soft and thick, and the yellow eyes, surrounded by radiating hair, like the feathers round an owl's orbit, large and staring. They are of small size, the body measuring some twelve inches, and the tail little longer, both thickly covered with the grayish brown fur. The muzzle is not prominent, and as the septum of the nose is narrow, the nostrils lie closer together than is usual in the New World apes. *N. trivirgatus*, which was first described by Humboldt from the banks of the river Cassiquiare, near the head waters of the Rio Negro, owes its specific name to three distinct linear black streaks on the crown, which are irregular and confused in its congener, from which it is further distinguished by an elongated yellowish frontal spot. Both of these forms have a cylindrical tail, very different from the broad, depressed, squirrel-like tail of a third, longer-haired species, *N. lemurinus*, which is found in Colombia, is destitute of the head streaks, but has a pale spot over each eye.

These nocturnal monkeys are readily tamed, are more confiding, and, if handled gently, more willing to be caressed than the *Cebi*, but are just as inquisitive, if less mischievous, than these. Bates describes their cry as hoarse, like the suppressed barking of a dog. Their insectivorous habits render them valuable inmates of the houses on the Amazon, and they are said to keep the rooms clear of bats, as well as of vermin. When handled roughly the little creatures defend themselves with their claws, striking and hissing like a cat, but they also know how to use their teeth.

Allied to the foregoing in the large size of the eyes, but strictly of diurnal habit, the species of *Chrysothrix* have certain other well marked peculiarities, which make the genus a very well defined one. The fur is soft and thick, the long tail hairy throughout, and hardly strictly prehensile, but still of assistance in locomotion. The eyes are so large that the bony septum of the orbits is partly incomplete, and mostly membranous; on the other hand the septum of the nose is broad, so that the nostrils are not so close together as they are in the *Nyctipitheci*. Most singular is the mode in which the skull is prolonged backwards beyond the foramen magnum. Of course the contained cerebral hemispheres have likewise this great size behind, so that their posterior lobes are much larger in proportion than in other monkeys. Three species of these Saimiri or Titi monkeys are described, *C. sciureus*, *C. ustus*, and *C. entomophagus*. The last-mentioned has black hair on the head, although the general color is golden brown, while the other two have grayish-black hair. The best known is *C. sciureus*, which is characterized by the possession of a much longer tail than the others, and is described at some length in "Humboldt's Travels," as it occurs extremely commonly, in great troops, on the banks of the Orinoco. The hair on the face is whitish,

but the naked skin round the mouth and nostrils is of a bluish-black color, and stands out very distinctly against the rest. More than in any other of the Cebidæ do we see here the disproportionate length of the hind over the fore-limbs.

The tail is very often coiled round the body in repose, as represented in the figure, and Humboldt describes little groups of the titis crowding closely together in this attitude, for warmth, their arms intertwined, and those that have been left out in the cold screaming piteously to be admitted. Fruits, small birds, and insects form the food of the saimiri; that insects are particularly relished, an observation of Humboldt would go to show, who, turning over the plates of Cuvier's "Natural History"



FIG. 231. — *Chrysothrix sciureus*, titi monkey, death's head.

before his pet titi, found that skulls, bones, etc., of various animals were allowed to pass unnoticed, while insects of various kinds were immediately recognized.

The genus *Callithrix* is distinguished from the foregoing by the rounder and more normal shape of the smaller head, the moderate size of the eyes, the much smaller canine teeth, and by the fact that the hair of the tail is somewhat longer. Eleven species are described, which are sometimes spoken of as Titis like the foregoing, but according to Bates are the Whaiápusai monkeys of the Indians. They are all of small size, and unlike the titis proper are dull, listless, and destitute of vivacity in captivity. They occur in small flocks, and do not appear to be active. Few of the species seem to have been carefully studied. Von Humboldt, however, gives an interesting account of the Macavahu, called by the missionaries Viudita, or Widow-in-mourning (*C. torquatus*). The coat is glossy black with an infusion of dark reddish brown, the face whitish, the neck with a white collar, the hands white, and the feet and tail black.

This monkey has a wild and timid air, often refuses food even when hungry, remains motionless for hours, but at the sight of a bird regains all its activity, springing after its prey and killing it like a cat. Humboldt found this species on the right bank of the Orinoco, but it also occurs on its tributary, the Guaviare. A closely allied form with a white chest spot, *C. amictus*, occurs in Guiana. The color of the feet is a useful diagnostic mark; thus in *C. cuprea* of the upper Amazons these are reddish brown like the under parts generally, while the back is dark gray. *C. donacophilus* is of uniform gray color, as are *C. moloch* and *C. ornatus*, while *C. personatus*, *C. nigrifrons*, *C. castaneoventris*, *C. melanochir*, have all black hands and feet. The



FIG. 232.—*Brachyurus calvus*, scarlet-faced uakari.

last-mentioned species is destitute of the long hairs which are intermixed with the soft fur of the others, and these may be distinguished by the diagnostic characters embodied in their specific names.

The second sub-family, Pitheciinæ, includes two genera (*Brachyurus* and *Pithecia*) differing from each other materially in the development of the tail, which is short in the former, only about one third of the length of the body, and longer than the body in the latter, but agreeing in the shape and direction of the lower incisors, which shelve forward somewhat in the same way as in the lemurs. The members of this group are of larger size than those of the last, but possess little of the vivacity or intelligence which we shall find in what is unquestionably the highest sub-family, the Cebinaæ.

The generic name *Brachyurus* incorporates the most characteristic peculiarity of the Uakari monkeys which we have next to deal with, — the extreme shortness of the tail. This, which is not surprising in these monkeys of the Old World, like the macaques and baboons which are purely terrestrial in their habits, is, nevertheless, an interesting phenomenon in animals which are purely arboreal, especially in view of the fact that most of the New World monkeys make more or less use of the tail to assist them in locomotion. Bates, to whom we are indebted for the most exhaustive account of the best known species of uakari, the Scarlet-faced or White species (*B. calvus*), states that it is extremely limited in its range, being confined to a forest tract of some sixty miles in extent near the mouth of the Japurá river, thirty miles from Ega. This tract is inundated during the greater part of the year, so that in spite of the want of a prehensile tail the uakaris are of necessity permanently arboreal in their habits. Their limited range appears to be the result of inability to accommodate themselves to other surroundings, for there is no natural barrier to prohibit them from extending southwards, and this is further indicated by the fact that they rarely survive when sent down the river, although on account of their very remarkable appearance they are frequently sent away as presents. They are not amusing pets unless caught very young. Adults which have been secured by the natives by the use of arrows slightly poisoned with urari, and cured by the internal administration of a pinch of salt as an antidote, rarely become tame. They are peevish and sulky, biting if they are handled, and resisting all attempts at coaxing, and very soon become listless and die, apparently of inflammation of the lungs.

Apart from the shortness of the tail the genus is further marked out by a peculiarity of the upper incisors, which are oblique, and converge in such a manner as to leave a space between them and the canines, while the lower incisors are much inclined forward. The food of the uakari is composed of various fruits, which they secure while running nimbly about from tree to tree, not leaping like many of the New World apes, but still progressing with such rapidity that it takes an expert hunter to track a monkey even after he has wounded it with his poisoned dart.

The body is as high as long, about eighteen inches, and clad with long, shining, white hair, which gives place to a short gray crop on the head otherwise nearly bald, and to bushy, sandy whiskers which meet underneath the chin. Reddish yellow eyes and a brilliant scarlet complexion complete a very remarkable *tout ensemble*. The young specimens do not possess the scarlet complexion, which only makes its appearance with maturity.

Two other species, *B. melanocephalus* and *rubicundus*, have been established for allied forms, in which black and red hues prevail respectively. The latter species is found on the north bank of the Amazon, not passing eastward of the river Ica. According to Forbes it is the western representative of *B. calvus*, from which, however, its rich chestnut hues at once distinguish it. *B. melanocephalus* is at once the most northerly and most widely distributed form, being found in the forests bordering the Rio Negro from Moura to Marabitanas. Its characteristic coloring is black on the face, head, legs, and under parts, giving place to chestnut brown on the back and sides.

The genus *Pithecia* is specially remarkable for the arrangement of the hair on the head, which resembles a wig with the hair parted along the middle line. The coat is sometimes of long, coarse hair, but it is shorter and silkier in some species. The chin is bearded, but the length and size of the beard vary with the species. Short, strong

limbs, and a thick, bushy, fox-like tail further aid in the recognition of the genus. Travellers describe the voice of these monkeys as very powerful; they live in small troops, feed on fruits, and are not very frequently met with in captivity, although Bates records a case of *P. monachus* which showed an almost unparalleled amount of attachment to its master. The species with softer hair are commonly known as Couxios, those with harsher hair, on the other hand, as Yarkees.

One of the best known species is the Black Couxio, *P. satanas*. Like all the others it has the long hair and thick bushy tail, the hair on the head looking like a wig, and radiating from a central line. Although generally black, the coat of this species takes on a brownish hue in the region of the upper Amazons. This species is replaced in



FIG. 233. — *Pithecia satanas*, black couxio.

Guiana by a yellow-backed form, *P. sagulata*, but various varieties of *P. satanas* are known to occur at different points of its range, such as a White-nosed Couxio, *P. albinasa*.

Another species of the same genus is the Parauacú Monkey (*P. monachus* or *hirsuta*), which obtains a remarkable physiognomy from the hood of hair hanging over and almost concealing its face. The coat is of speckled gray color, and extremely harsh in texture, but thick everywhere, and clothing the tail to the tip. While the body measures eleven inches, the tail is as much as eighteen, so that this species resembles the foregoing in this respect. Bates observes that this species is a timid, inoffensive creature, an affectionate pet, capable of forming strong personal attachments, and not deficient in intelligence. He found it on the dry lands on the north shore of the Soli-

moens, whence it extends westward into Peru and southward as far as the banks of the river Teffe, where, however, it soon becomes replaced by a white variety, *P. albicans*. A better defined species is *P. leucocephala*, which extends from the Amazon up into Guiana, is entirely black, with the exception of the yellowish or whitish wig, which is subdivided by a central black mark. *P. rufiventer* is distinguished by its grayish black hairs, annulated with yellow, which are replaced by red hues on the under parts, and a yellow moustache. The four species just mentioned are sometimes called Yarkees, from the name under which Buffon describes the Parauacú.

Of all the American monkeys there is none more characteristic than *Mycetes*, the sole genus of the third subfamily Mycetinae, including all the Howlers, which make the Brazilian forests dismal night and morning with their portentous cries. Like the spider-monkeys, and certain others to be presently described, the howlers have an extremely strong and prehensile tail, which is naked and callous on the under surface toward the tip, and is quite as efficient as a fifth hand. But certain features mark them as a tribe or sub-family apart. The distribution of the hair is peculiar; it forms long, rigid whiskers encroaching on the face toward the nose, and depending from the chin and swollen throat in a long beard. The under parts are almost naked, but the back is clothed with long, coarse hair, varying in color with the species. All possess the remarkable resonating apparatus in the windpipe, by the aid of which, with apparently very little exertion, their loud cries are uttered. As many as five sacs serving as resonators may be present; the chief of these is median in position, is lodged in the very much expanded hyoid bone, and communicates below with the windpipe. The others are paired; two constantly present are the enlarged "ventricles" of the larynx; the others are partly formed by the wall of the hinder part of the mouth cavity. It has been conjectured that the cries of the howlers serve to intimidate their enemies, and all travellers are agreed in describing them as a by no means pleasant feature in the already sombre and gloomy forests. But this explanation would hardly account for the circumstance that the howls are rarely uttered intermittently or when the animals are alarmed, but morning and evening in concert under the guidance of a sort of precentor. To accommodate the enlarged hyoid bone the lower jaws are much enlarged vertically, especially behind. Further distinguishing features are the large canine teeth, the powerful limbs and tail, the long and strong digits, including well-developed thumbs, all armed with strong convex claws.

The howling monkeys are caught frequently enough, but they are quite untamable, and as long as they survive in captivity exhibit the same sullen and ferocious temper. They are decidedly the least intelligent of the larger New World apes, and the structure of their brain, as Professor Flower observes, fully bears out this inferiority. They live in small groups in the tops of high trees, on the leaves and fruits of which they depend for nourishment. No important differences have been observed as to the habits of the various species. Some of these appear to be much restricted in their range, perhaps because of the fear of water, which seems to be common to all. But the whole genus, although it does not extend into Central America, is perhaps more widely distributed than any other throughout South America from the coast of Venezuela south to Rio Grande do Sul. Our figure represents the most southerly form, *M. caraya*, the Black Howler, which, with several other species (*M. auratus*, *M. barbatus*, *M. beëlzebul*, *M. villosus*), has hair on the forehead directed forward, and that on the crown all of one length and radiating. All of these species are black with the exception of the red and yellow *auratus*, while *M. barbatus* and *beëlzebul* may

be readily distinguished by their gray and yellow feet respectively. Other species are marked by the reflexed hair on the forehead, forming a ridge across the centre of the crown. These include the more northern forms, such as *M. ursinus* and *seniculus*. The former, known as the Araguato, or Guariba monkey, appears to be extremely variable in coloring, the females and young males being yellow (Bates describes them as dingy white with tawny whiskers), and the males brown or blackish, merely yellow-washed. *M. seniculus*, however, is chestnut red, the middle of the back golden yellow, and the hairs of one color throughout their length. Renewed study is required to show the range of these species and their relations to each other. Wherever they occur they are hunted by the Indians, who relish their flesh, although the white man's stomach is apt to turn at food which, as Bates remarks, is so suggestive of cannibalism.

They are occasionally hunted by means of dogs, which also appreciate their flesh, but they are sometimes difficult to secure unless mortally wounded at once, for, by virtue of great tenacity of life, they may manage to escape, although badly wounded. They conceal themselves, too, in the thick foliage of the lianas, which form their night quarters, with such adroitness that much time may be expended in getting a shot. The flexor muscles of the tip of the tail are naturally so powerful that no amount of wounding will bring the creature down if it has once fixed itself, and travellers agree in reporting that dead howlers may hang for days in this position. Such an organ is, of course, of the greatest value in locomotion, and the howlers, which are slow and careful in their movements, secure themselves constantly while making their way from branch to branch by its aid. The movements of the troop are performed in concert like their cries, so that the animals, were it not for their solemnity, look as if they were engaged in a game of "follow my leader."

The subfamily Cebinae includes the four remaining genera, *Cebus*, *Lagothrix*, *Eriodes*, and *Ateles*, which, in respect of cerebral development, and consequent intelligence, adaptation to rapid arboreal locomotion and vivacity, deserve to be regarded as the highest of the New World apes. In all, the tail is prehensile, more characteristically so in the three last genera, where it is naked on the under surface towards the tip, but in all used in locomotion. In none is the windpipe modified in the extraordinary way noticed of the last group, and the hyoid bone and lower jaws are consequently more normal in their form. Unlike the Pitheciinae the incisors are vertical; the canine teeth may be large as in *Cebus*, or small as in the other genera, but the molars have in all the characteristic formula $\frac{2}{1}$.

The genus *Cebus* is sufficiently characterized by the extremely long tail, which is curled at the end, but hairy throughout. In all the species the thumb is well developed; the head is large-sized and elongated, the hair is short and arranged on the head so as to afford diagnostic characters for the different species. Of all the American monkeys these are more frequently met with in menageries, as they appear to adapt themselves with comparative ease to colder climates.

The members of this genus are frequently known as Sapajous, or, in the Tupi language, Caiatára, a term which means macaw-headed, and refers to the disproportionately large head of these monkeys. They are among the most intelligent of the New World apes, but are extremely restless and changeable in their moods. Some species, like *C. cirrhifer*, are better tempered, playful, and if tricky, not malicious, but others share the mental traits of *C. albifrons*, which is referred to below. Mr. Romanes, in his "Animal Intelligence," gives an interesting account of the Brown Capuchin, *C. fat-*

uellus, confirming and extending the earlier observations made by Rengger in South America on the same monkey. The result of upwards of two months of careful observation showed that this little creature was possessed of a tireless spirit of investigation, and showed the greatest satisfaction when it had discovered any mechanical principle, such as that of the lever or screw, and was never tired of employing them in the most mischievous manner. It had a keen sense of the ludicrous, and felt bitterly when laughed at. It formed its attachments apparently in the most capricious way,



FIG. 234.—1. *Cebus leucogenys*. 2. *C. apella*. 3. *C. hypoleucus*. 4. *C. olivaceus*, sapajous.

and screamed in the most piteous manner to be taken notice of by the people whom it liked.

We follow Gray in the arrangement of the species. In *C. leucogenys* the silky coat is of blackish color, but is shorter on the head, and reflexed round the margin of the face, where it forms a pair of whitish-yellow whiskers, and a short crest over each eyebrow. *C. apella*, *pallidus*, *cirrhifer*, and *vellerosus* agree in having a dark crown spot, on the sides of which the hair forms two elongated crests or even tufts. *C. apella* is from Guiana, and is one of the monkeys most frequently exported from South

America. It appears to be replaced further south by a variety, *C. fatuellus*, in which the hair of the head is much longer and thicker, transforming the crests into horn-like projections. The species varies much, but the shoulders are generally lighter in color than the reddish-brown tint of the rest of the coat. To the next group of species belong forms, *C. capucinus*, *olivaceus*, *albifrons*, *hypoleucus*, in which the hair is short and reflexed all over the crown, but is not elevated into a crest. The first of these, the Capuchin, is readily distinguished from the others by the expanse of naked wrinkled forehead. It is one of the larger forms, the body measuring eighteen, the tail fourteen inches, and is of golden brown color, which gives place, to yellow on the front parts.

Bates gives a graphic description of the light brown species of this genus, *C. albifrons*, which is everywhere commonly distributed through the forests of the upper Amazons, and is recognized by its white forehead. They live in troops of thirty or more, advance through the trees in single file, and when they have reached the outermost boughs of a tall tree the leader does not hesitate to precipitate himself fifty feet or so to the next tree, where he rights himself instantly by means of his hands and tail, and is followed without intermission by the others. They are frequent pets, not particularly playful, but restless, irritable, and discontented. One which Bates had for some time especially showed this waywardness, not being happy even when supplied with plenty of bananas, its favorite food, and keeping the house in an uproar with its pitiful screams when either alarmed, hungry, or jealous. In a fit of jealousy this *Cebus* killed one of its fellow-prisoners, a *Nyctipithecus*, and fell from his owner's favor in consequence.

The tendency to have paler colors in front reaches its maximum in *C. hypoleucus*, which is black except for the white forehead, neck, and shoulders. This form, although found in Guiana, ranges as far north as Costa Rica. *C. olivaceus* is one of the largest forms, the body measuring twenty-four, the tail twenty inches. Of the other species we mention *C. robustus*, a red species with a single central crest; *C. chrysopus*, of grayish-brown hues, becoming golden yellow on the outside of the limbs, in which the hair of the head radiates from a central spot; and *C. capillatus*, in which the hair of the head is somewhat longer, diverges in all directions, and thus forms a sort of cap.

The other genera of Cebinae have the tail naked under the tip. Of these, *Lagothrix* has well-developed thumbs, comparatively short limbs, soft, woolly black hair, which is short and directed backwards on the crown. Two species have been distinguished, *L. humboldtii*, which is grayish-black, and *L. infumatus*, which is reddish-black; these are known as Capparas or Barrigudos by the Indians.

The Barrigudo, according to Bates, is the largest of American monkeys, with the exception of the black howler, the body in which attains a length of twenty-eight inches. The extreme length of a barrigudo is fifty-three inches, of which twenty-seven belong to the body. A strikingly human aspect is given to the face by the projecting eyebrows and shape of the forehead. The barrigudos are gregarious, arboreal, and fruit-eating; they are graver in their manner, milder in temper, but not so active as many of the other apes. They are much persecuted, according to Bates, by certain Indians for the sake of their flesh, one horde of two hundred Tucuna Indians alone killing as many as twelve hundred per annum for food. They are met with on the upper Amazons and on the Orinoco, and bear transportation from their native forests very badly.

There now remains for us to discuss those species of Cebinae which have received the familiar name of Spider-monkeys, on account of the slenderness of the body and the length of the limbs. They have been ranged under two genera, which agree with each other in the absence or extremely rudimentary condition of the thumbs, but differ in the nature of the coat. The first of these, *Eriodes* or *Brachyteles*, has occasionally a rudimentary thumb, the hair is soft and woolly, and directed backwards on the head,



FIG. 235. — *Lagothrix humboldtii*, barrigudo.

while *Ateles*, the remaining genus, to which most of the species belong, has harsh hair, directed forwards on the head. According to the more or less rudimentary condition of the thumb, the forms of *Eriodes* have been divided into three species, *E. arachnoides*, in which it is absent, *E. hypoxanthus*, in which it is pretty well developed, and *E. hemidactylus*, which holds an intermediate position in this respect. Dr. Gray prefers to unite all under *E. arachnoides*. He points out that the condition of the thumb is subject to much variation, and that it may be present on one hand and absent on the other.

The teeth furnish certain other characters which separate this species from the other spider-monkeys, for the incisors are of small and equal size, and the molars very thick and quadrangular, while in *Ateles* the middle incisors are very long and broad, and the molars are small and rounded; ashy brown hues prevail, the coat of *E. arachnoides* reddening towards the tail, and occasionally paler on the under parts. The species is of large size, and inhabits the interior of Brazil, where it is known as the Miriki.

The miriki appears to agree in its habits with the other spider-monkeys. The movements of all on the ground are extremely awkward; the great length of the forelimbs is obviously an adaptation to arboreal locomotion, and it is believed that, in a state of freedom, they never leave the trees in which they live except it be impossible to drink without doing so. The most remarkable positions are assumed in their movements from branch to branch; the tail, which does not only serve for hanging on, is often sent on ahead to bring a distant branch within reach, and is even employed for the purpose of bringing food to the mouth. That such should occur is not surprising when we think of the hands destitute of thumbs. Although not possessed of the remarkable vocal powers of the howlers, the spider-monkeys can make themselves heard to a considerable distance, the windpipe being slightly modified in the direction which reaches its maximum in the howlers.

Ateles paniscus, the large black spider-monkey, or Coaita, is covered with abundance of coarse hair, the prominent parts of the face standing out the more on account of their tawny flesh-colored hue. It is the largest of the American monkeys, with the exception of the more bulky barrigudo. It extends, according to Bates, throughout the lowlands of the lower and upper Amazons. Beyond the limits of the river plains it is replaced, however, by the white-whiskered coaita. In spite of their leanness and slenderness, the coaitas are much appreciated for the table. Their disposition is extremely mild, much more so than that of the other Cebidæ, and they are constantly met with as pets. Bates met with one old female in the captive condition whose master could make it extremely unhappy by using vituperative language to it, and immediately restore it to good spirits by a few kind words. They have none of the restless vivacity of the capuchins, or the surly temper of the howling monkeys. They are readily caught in the upper Amazons, by the usual Indian method of employing a blowpipe dart, weakly poisoned by urari, and administering afterwards a little salt as an antidote. *A. ater* is distinguished from the common coaita by its black face, *A. fusciceps* by the brown hair on the crown, *A. gridescens* by its grizzled coat, while *A. cucullatus* has a well-marked hood of hair expanded over the eyebrow.

The White-whiskered Coaita, *A. marginatus*, is of similar size to the ordinary black spider-monkey, but is distinguished by its whiskers and a triangular white patch on the crown. Bates says that its meat was richer and sweeter than beef, the best flavored meat he ever tasted, and very welcome up the river Tapajos, where the diet was largely composed of fish. Spider-monkeys, however, are not hunted merely for the sake of their flesh; the skins are of considerable value, and form an article of export from Brazil.

According to Sclater the Black-handed Spider-monkey, *A. melanochir*, of Central America, is a very variable species, extreme forms of which have been described as *A. ornatus* and *A. albifrons*. The lighter-colored specimens with white forehead (*A. albifrons*) are from Nicaragua; the darker, in which the ordinary colors are all intensified (*A. ornatus*), from the Pacific coast of Guatemala. Pale brown or ruddy

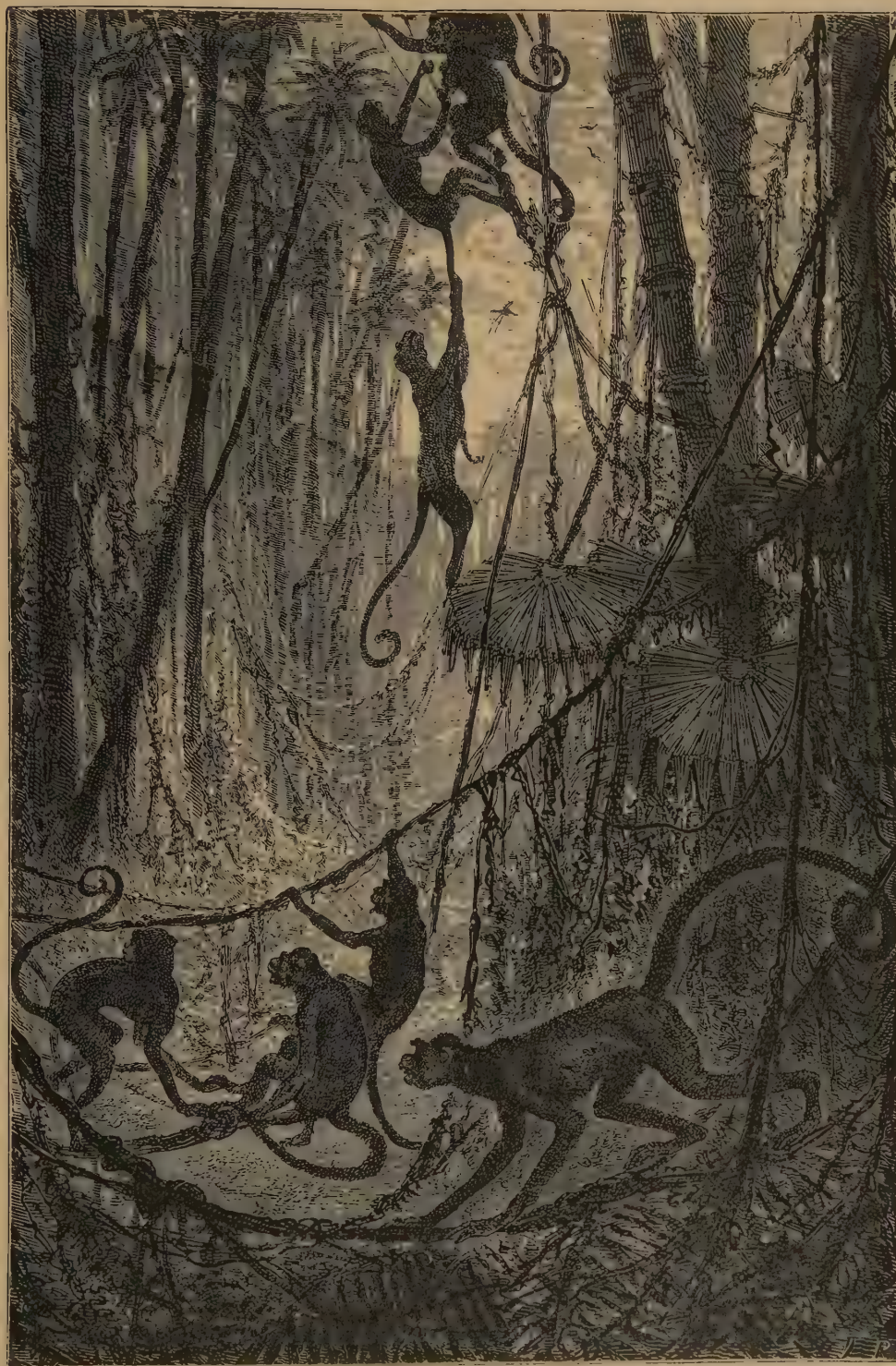
brown hues characterize the more central forms, the forehead, hands, and feet being black, while the vertex is of a browner red than the rest of the coat.

A near geographical neighbor of the above is *A. rufiventer* from the river Atrato in Colombia. It is all black except the red belly and flesh-colored face. In comparison with many of the others it is of small size, measuring merely some twenty-seven inches, of which twelve belong to the body.

Certain species differ from the foregoing in having the inside of the limbs differently colored from the back. One of these is found further to the north in America than any other ape. This is the *Ateles vellerosus*. According to Reinhardt, this spider-monkey lives in small troops in deep "barrancas" up to an elevation of two thousand feet on the volcanic mountain of Orizaba in Vera Cruz; also in eastern Oaxaca to an altitude of four thousand feet; but he never met with this or any other species of monkey on the Pacific slope of the great Cordilleras in Oaxaca, or on the west coast at all north of Tehuantepec. It differs from *A. belzebuth*, of which it appears to be the Mexican representative, in having the under side of the tail as black as the upper, in the longer fur spreading out in all directions on the head and body, and in the fact that the pale color of the inside of the arms does not come down so near the hands. It is a very distinct form from its nearest geographical neighbor, the black-handed spider-monkey of Central America, already described.

As the term Platyrrhini is sometimes employed to designate the New World apes, so those of the Old World have been called Catarrhini, on account of the narrowness of the nasal septum, and the consequent downward direction of the nostrils. Following the plan hitherto adopted, we prefer the family name SIMIADÆ for the group, which is formed from the generic name *Simia*, originally employed by Linnæus in a much wider sense than at the present time. In their dental formula ($i. \frac{2}{2}, c. \frac{1}{1}, pm. \frac{3}{3}, m. \frac{3}{3}$), the Simiadæ agree with man, although the teeth are not arranged in a continuous series, but have gaps between the upper incisors and canines for the reception of the lower canines. Even within the limits of a single genus the tail is subject to much modification. It is sometimes longer than the body, sometimes it is absent, but it is never prehensile as in the Cebidæ. Neither do we find claws as in some of that group; the digits are always furnished with nails. The thumb may be absent, as in the *Colobi*, where the hand is converted into a mere hook for hanging on to boughs like that of the spider monkey; but when present it can be opposed to the other fingers. Two peculiar features are often met with in the Simiadæ which are never present in the Cebidæ. These are the cheek pouches and the ischial callosities. The former open into the cavity of the mouth by slit-like orifices just behind the angle of the lips, whence they extend outside and below the lower jaws, and are often to be seen much distended with food. The latter are naked spots, often of considerable size, which occupy the hind quarters over the ischial bones, and are frequently very brilliantly colored. Directly over the tuberosities of the ischia the epidermis forms thickened horny pads, whence the name callosities applied to these structures.

On the whole the brain of the Old World apes is higher in its organization than that of the New World forms, and the animals are consequently more intelligent. The members of the genus *Cebus* alone may be compared favorably with some of them, and indeed their movements and general habits recall the *Cercopithec*i of the Old World. It may not be amiss to give here a short account of what is known of monkey-psychology, which Mr. Romanes discusses at some length in his "Animal Intelligence."



Spider monkeys.

He remarks that monkeys have never enjoyed the improving influence of hereditary domestication as has, for example, the dog, and that consequently it is merely their natural intelligence we have to deal with. In that, he concludes, as well as in their anatomy they approach more nearly to man than any other animals. Sympathy has been observed in many different forms. The female gorilla has been said to die of grief when the young is taken away; oranges have come in a body to beg for the corpse of a dead companion; gibbons for a wounded comrade. A female gibbon has been observed to wash the face of her young, a *Cebus* to brush off flies from the face of hers while sleeping, and all monkeys assist each other with the utmost zeal in the search for intruders in their hair. They have been noticed to feed each other, to carry food to sick monkeys, and to adopt orphans. More remarkable than all, a monkey has been seen to throw a rope to a comrade who had fallen overboard. That all monkeys are fond of play, especially when young, is notorious; they have a keen sense of the ludicrous and enjoy exciting laughter, but they resent being jeered at, and may revenge themselves as in the case of a Cape baboon, which bespattered with mud an officer in his dress uniform who had offended him. Curiosity is indicated in various ways; none more characteristically than that first recorded by Brehm, but confirmed by Darwin and A. E. Brown, that if some snakes, of which monkeys have an innate horror, be rolled up in paper and put in the cage the monkeys are not satisfied until they have undone the paper to assure themselves that nothing else is there. The entellus does not share this horror of snakes; it is said to seize venomous serpents, break their poison fangs, and eat them. So the Cape baboon destroys the stings of scorpions before eating them. Monkeys readily learn from experience; they learn how to eat eggs without spilling their contents, to abstain from strong drink if it has once produced the direful consequences of next morning, and to take advantage in various ways of any mechanical trick they may have learned. They are great imitators, and readily learn in this way the use of keys, hammers, etc. All observers agree, in fact, that the difference between the psychical phenomena of an adult Bushman, a European infant, an adult Cretin, and those of certain of the higher apes is one of degree not of kind, and when there is a difference it is not always in favor of man.

All the higher anthropoids, and many of the lower Old World apes attain a larger size than those of the New World. The period of gestation is usually some seven or eight months, and there is no special rutting season as is common with other orders, so that the young are born at all seasons of the year. The mothers show great affection for their young. The apes are mostly confined to tropical Asia and Africa, some few forms passing beyond the ordinary northern and southern limits.

The Simiadæ are conveniently divided into two subfamilies, of which the Cynomorpha are characterized by the produced snout, the less length of the anterior limbs, the frequent presence of cheek-pouches, and the constant occurrence of ischial callosities. The Cynomorpha tread upon the whole surface of the hands and feet, while the higher anthropoid, or more man-like apes (Anthropomorpha), walk clumsily upon the knuckles or on the outer border of the feet. The Anthropomorpha never have cheek-pouches; ischial callosities are only present in the gibbons, the tail is absent, the skull rounder, and the anterior limbs longer than in the lower forms. In the pattern of the molar teeth, and the relative size of the lower incisors, the Anthropomorpha approach man and differ from the lower forms. The sternum is also broader, so that they are sometimes called 'latisternal' apes.

The baboons certainly form the most typical of the Cynomorpha in so far as the elongation of the face, the size of the canine teeth, and their terrestrial habits confer upon them a dog-like appearance. This resemblance is specially marked in the face, whence the generic name *Cynocephalus*. The best known species is *C. babuin*, which extends from Nubia and Abyssinia towards central Africa, where it is regarded as a sacred animal by some of the tribes, as the hamadryas probably was in bygone times



FIG. 236.—*Cynocephalus babuin*, common baboon.

in Egypt. The baboons live in large troops in rocky places, but descend to the river beds once a day to drink. Their food consists of tamarinds, berries, gum from the mimosas, and grubs which they hunt for by turning over stones. These same stones may be employed as offensive weapons by the baboons if necessary, and many instances are recorded of their making attacks in concert from secure places from which it was impossible to dislodge them. Baker describes the method adopted by the Hamran Arabs to catch the 'girrits' as they call them, and they are easily ridden down if the ground is not very broken, and the young are then snatched from the backs of the



Hands and feet of monkeys.

1-2. Gorilla. 3-6. Tschego. 7-8. Chimpanzee. 9-10. Orang. 11-13. Gibbon. 14-15. Guerza.
16-18. African green monkey. 19-20. Baboon. 21-22. Marmoset.

mothers, where they ride during a retreat, and as a preliminary step for further training receive a sound whipping with the Arab coorbatches.

The tail is cylindrical and of considerable length in this species, as much as twenty inches, one third of the whole length of the animal. Two allied species, one somewhat larger, from the Cape of Good Hope, the Chacma (*C. porcarius*), and one rather small in size from West Africa (*C. sphynx*), agree with the baboon in this respect. In the chacma, however, grayish black hues prevail, giving place to black on the head, tail, hands, and feet, and there is a well-marked crest of hair along the neck. The sphynx



FIG. 236. — *Cynocephalus mormon*, mandrill.

is ruddy brown, and the common baboon brownish yellow in color, darkening on the back and paling on the cheeks. All the species of this section agree in the large size of the callosities, which are generally of red color.

Two baboon-like apes from the Gold Coast of West Africa are occasionally separated from the baboons proper under the genus *Mormon*, on account of the rudimentary tail and the remarkable grooved swellings on the face. The smaller and most baboon-like of these, the Drill (*Cynocephalus leucophæus*), carries the short tail, which is hairy all round, erect, and the two grooves on the face are not remarkable. It derives its specific name from the white beard and copious white whiskers, which contrast with the black face and brown fur. Its common name drill appears to have been at one time employed generally for any large ape, and forms part of the name

of its nearest ally the Mandrill, *C. mormon*. The disproportionately large head, the small eyes, the swollen, brilliantly-colored, grooved elevations on the sides of the nose, immediately distinguish this species. The hair is black and yellow-ringed, forming a pointed crest over the crown, and paling near the mouth. Like the drill it has very large callosities, but the short tail, not much over an inch in length, is naked on the under surface. It is only when adult that it acquires the full brilliancy of the blue and red coloration of the face, and naked hind-quarters.



FIG. 237. — *Cynocephalus hamadryas*, hamadryas.

The Hebe of the Abyssinians, or Hamadryas (*C. hamadryas*), is a species sharing with the following the habits of the baboons proper, but differing from them in the long hair, which forms a shoulder-cape, protecting the upper part of the body, and particularly well developed in the old males. From the sides of the flesh-colored face diverge long slate-colored whiskers, which stand stiffly outwards. The fur is of ash-gray color, and the tufted tail some eight or ten inches in length, about one quarter of the entire length. Mr. Parkyns describes the regular system of tactics which these baboons employ in war, pillaging expeditions, robbing cornfields, etc. A tribe coming down to feed, from their village on the mountain (usually a cleft in the face of some cliff), brings with it all its members, male and female, old and young. The maned

elders act as leaders and scouts, calling out at times to preserve order in the band, which, unless they be apprised of danger, are a noisy and disorderly crowd, trusting entirely to the vigilance of their scouts. These do not take part in foraging, but await for a partition of the spoils, which are stowed away in the cheek pouches. They show great sagacity in discovering and digging for water. Their huge canines make them formidable enemies, but they rarely assume the offensive.

Another Abyssinian species, first described by the traveller Rüppell, is *Gelada rüppelli*. It was originally described as a *Cynocephalus*, but Garrod believes it to be more nearly allied, in certain respects, to *Cercopithecus*. A female described by him measured fifty-four inches in length, twenty-five of which belonged to the tail; but the males are said to attain much greater size. The general coloring was sooty brown, turning to black on the shoulders and anterior extremities, and paling on the abdomen. The hair between the shoulders attained a length of eleven inches, and extended over the occiput to the superciliary ridge, and down to the loins. Most characteristic are two triangular naked spots on the throat, surrounded by iron-gray hair, with their apices pointing towards each other, thus forming an hour-glass pattern. Below the forehead the face is nude; the ischial callosities are only two inches in diameter, and are situated in a naked area, of carmine color, in the females. The fifth lobe, which is present in the last lower molar of *Macacus* and *Cynocephalus* is large here, although it is absent in *Cercopithecus*. The gelada shares the habits of the last species.

Differing from the true baboons in the rudimentary nature of the tail, as well as in the shape of the face, the Crested Baboon of Celebes and the Philippine Islands is regarded as an independent genus, and named *Cynopithecus niger*. The coloring is occasionally brownish or grayish, but the coat is generally of a deep black, and of considerable length, especially on the crown, throat, and arms. The overhanging brows, flattened nose, with nostrils behind the mouth, and especially the crest, render this species easily recognizable. Wallace observed it in Celebes, living in large bands in the trees, but often descending to the ground for the purpose of robbing gardens and orchards. He describes it as of the size of a spaniel. This species extends further east than any other monkey: in its geographical distribution, as well as in certain anatomical features, it leads us naturally to the characteristic oriental genus *Macacus*.

Of the many species described we figure three of the commonest Indian forms, and the Wanderoo, a species which differs from all the others in having whiskers and beard of enormous proportions, encircling the whole face. Not only the length and form of these, but also their color, render this monkey easily recognizable, for they stand out gray or white against the deep black of the rest of the coat. The tail is rather over a foot in length, about half as long as the body, and is tufted at the extremity. The wanderoo inhabits the deep jungle of Malabar in considerable numbers, and has been introduced and naturalized in China. His white whiskers and beard have caused him to be named after the leader of the older satyrs, *M. silenus*, but it would appear that the specific name is not intended to cast any reflection on his morals, for he is certainly no worse in this respect than many of his congeners.

The Common Macaque (*M. cynomolgus*) may serve as a type for the rest of the genus. Instead of the somewhat oblong head of the preceding form the head itself is rounded, and the face considerably produced. Extremely prominent eyebrows overhang the face, and as age advances grow more prominent. The tail is not tufted, and is as long, or longer than the body in this and other species; whereas in certain of the forms it is extremely rudimentary. The young macaques are docile enough, but at

four or five years, the changes show themselves. No monkeys are met more frequently in menageries than the macaques; they are hardy, and breed readily in captivity. In fact, hybrids are known to occur more frequently among them than other monkeys. In habits the macaques hold an intermediate position between the baboons and the arboreal African monkeys, which we shall study next. Many of them are terrestrial, rock-loving forms, like *M. philippensis*, a species from the Philippine Islands, which repairs from the mountains to the rocky shores in search of crabs and similar food, or like the tailless magot, which hunts for grubs and insects underneath stones, as do the baboons, while other species appear to confine themselves more to vegetable food.



FIG. 238. — *Cynopithecus niger*, crested baboon.

Generally the long-tailed forms are arboreal in their habits, while the short-tailed are terrestrial. In addition to the common macaque, the Bonnet Macaque, or Munga of southern India, *M. sinicus*, may serve as an example of the long-tailed group. This species is somewhat smaller than the other, of greenish-brown hues, the hairs being annulated with yellow, as in many of the other forms, the under parts whitish. The arrangement of the hair on the head is very characteristic, that on the forehead being parted from a central line, while the longer hair, on the crown, looks as if brushed backwards. *M. cynomolgus*, on the other hand, has only short hairs on the forehead and crown, which may be brushed up into a short central crest in the females. The fur is reddish olive, the tail black, except for a gray line on the under surface, and gray tip.



Macacus cynomolgus, Javanese macaques.

In length of tail *M. nemestrinus* and *M. rhesus* hold a median position. The former species, remarkable for the length of the legs, and the thinness of the short tail, is of the two the more terrestrial. It is a native of the Malay Archipelago, and is the Bruh of the Malays. The coat is brownish washed with yellow, the hair on the crown longer, and forming a radiating tuft behind. *M. rhesus* is, on the other hand, a native of India, where it occurs both on the plains and in the hill-country. It is the Bunder of the Hindoos, and is not only tolerated for its propensities of stealing from plantations but even preserved, sharing some of the veneration which, we shall see, is accorded to another species of ape. The *rhesus* appears to be very widely distributed in Eastern Asia; many allied forms have been described, and it is not quite certain whether these are to be regarded as distinct species or not. In coloring the bunder is much yellower



FIG. 239. — *Macacus silenus*, wanderer.

than the preceding species, except for dark-gray hues on the fore limbs, and fulvous hues on the thighs. The tail is proportionally longer, thicker, and does not have the pig-like twirl of that of the bruh.

A species resembling the *rhesus* in the shortness of its tail, is the *M. sancti-johannis*. Swinhoe observes, that this form is to be found, split and dried, in the druggist shops of Canton and Hong-kong, and is, no doubt, regarded as very powerful medicine. On the island of Formosa also occurs an allied round-faced species, *M. cyclopis*. Two forms are readily distinguished from the others by the red color of the face. This is particularly brilliant in the Japanese *M. speciosus*, a monkey with soft yellowish-brown fur, very different from that of the allied *M. arctoides*, from the hill-country of Burmah, the coat of which is dark brown. Besides the red face these macaques are characterized by the shortness of the tail, a peculiarity which is shared by the woolly-coated *M. thibetanus*, from the snow-clad mountains of Thibet, and which is still more marked in the ashy-brown macaque *M. ochreatus*, and the black macaque of Borneo, *M. maurus*. In the latter the tail is little more than an inch in length.

The Barbary ape, or Magot (*M. inuus* or *Inuus ecaudatus*), extends from its home in northern Africa over to the nearest part of Europe, having been known to exist at Gibraltar for a couple of centuries at least. Mr. Busk found none of its bones, however, in the ancient breccia, and he is inclined, on this account, to suspect that it is a comparatively recent importation. Sayer's "History of Gibraltar" furnishes a curious corroboration of this view, for it appears, from certain documents, that a poll-tax was instituted in 1740 on apes, as well as on "Jews, Moors, and other aliens." The little colony



FIG. 240:—*Macacus sinicus*, bonnet macaque, and *M. rhesus*, bunder.

find protection and ample nourishment on the rock, and, although their numbers are small, there is apparently no danger of their being exterminated. The coat is yellowish-brown, owing to the individual hairs, which are blackish brown, having pale tips; the under parts are gray, and the cheeks covered by brushed-back whiskers. The tail is a mere tubercle. In its habits it is the most terrestrial of all macaques, and resembles the baboons in the nature of its nourishment and mode of securing it.

Throughout the greater part of Africa are found numerous troops of small monkeys, of slender form, extremely active habits, and often of striking coloring. These

graceful little creatures belong to the genus *Cercopithecus*, named so on account of the long tail, which all of them possess. Unlike the genera which follow, the thumb is of large size, and both hands and feet well adapted for running on the ground, as well as for arboreal life. Unlike them, also, the stomach is simple, and not sacculated. The face is not so produced as it is in the macaques and baboons, and they are unquestionably more arboreal in their habits. Like the baboons, however, they live in troops, and make systematic pillaging expeditions, headed by an old male, who conducts the troop and warns when danger is near, or reassures when nothing is to be feared. A great many species have been described, some of which, on account of peculiarities in the teeth, have been separated under the genera *Miopithecus* and *Cercocebus*. The first of these embraces only a single species, *M. talapoin*, with a rounded head, straight, rigid whiskers, of yellow color, contrasting with the black face, as do the olive-green upper and whitish under parts. The last lower molar has only three cusps, while in the *Cercocebi* it has five.

In the species of *Cercocebus*, known to dealers as Mangabeys, the face is more produced, the whiskers small, the eyebrows very prominent, the eyelids white, and the size greater than the *Cercopithec*i proper. Black hues prevail; thus *Cercocebus fuliginosus*, the Sooty Mangabey, is all black; *C. æthiops* has a white crown, and the under parts whitish; while *C. collaris* has a white collar, as also the cheeks, throat, and chest white. *C. albigena* is distinguished from the foregoing by a compressed crest of hair on the crown, while they have the hair short there, and directed backwards.

Of the true *Cercopithec*i we may mention first the common Green Monkey of Africa, *C. sabæus*. This species appears to have a wide area of distribution, as it is very common in Abyssinia, where it is called Tota, or Waag, and extends as far as the west coast, where its coloring appears to be a little darker. The coat is olive-green, darkening on the crown, hands, and feet, and the upper surface of the tail at its root. The long, rigid, whitish-yellow whiskers are connected over the forehead by a more or less distinct white frontal band, and are continuous with the white throat and underparts. The vent and base of the tail are gray, the scrotum green.

This species has been introduced into some of the islands of the Antilles, where it has become extremely common, and is very destructive to growing crops. Its introduction into St. Kitts took place about the year 1700.

Allied species are *C. ruber*, in which the fur is red, *C. pygerythrus*, in which the vent and the base of the tail are red, but the coat, generally, grayish green, and *C. cynosurus*, which has a flesh-colored instead of a black face. The geographical limits of these species are not known.

In the distribution of color in the coat *C. diana* and *C. mona* closely resemble each other. *C. diana* has black fur, grizzled with white. The frontal band, goat's beard, throat, chest, inside of the fore and hind limbs, and a mark crossing the haunches are also white. In *C. mona*, on the other hand, the fur is dark olive, the goat's-beard is absent, the face paler; there is a black streak from the eyebrows to the base of the ear, and the streak on the haunches is represented by a spot.

Dr. Gray has arranged the remaining species by the color of the nose. Thus, *C. cephus* has a blue nose, *C. petaurista*, *melanogenys*, *nictitans* (known as Hocheurs) have white hairs on the nose; *C. erythrotis* has reddish-bay ears and nose. Again, *C. erxlebenii*, which agrees with *C. albogularis* and *C. samango* in having the nose colored like the body, has a distinctive black temple streak. Only the best known species have been referred to above; numerous others are described.

The remaining forms of cynomorphous apes are usually ranged under two genera, the distribution of the species of which is sharply limited geographically, for *Colobus* includes merely African, *Semnopithecus*, on the other hand, only Indian forms. We have already noticed that *Colobus* is in so far a representative of the American spider-monkeys as the thumb is entirely absent. In *Semnopithecus* it is often rudimentary. Unlike the preceding forms these two genera have no cheek-pouches, but the first part of the stomach is dilated into a number of sacs, which serve for the reception of food, not for digestion. In both the head is rounded, and the tail of great length.

The Guereza (*Colobus guerza*) is one of the most beautiful of monkeys. The limbs, back, and head are covered with short, glossy, jet-black fur, while the cheeks, chin, and frontal band are white. Depending from the flanks is a long fringe of pure



FIG. 241. — *Colobus guerza*, guerza.

white silky hair, and the tail is terminated by a bushy tuft, of similar color and texture. The guereza is found in the mountainous parts of Abyssinia. They frequent the high trees, and when springing from bough to bough, the silvery fringe of the sides flapping out gives them almost the appearance of being winged.

A somewhat similarly colored species is *C. angolensis*, in which, however, the white lateral fringe is continued over the sides to the face. This form was first described from Angola; but similar specimens have been received from the Zanzibar coast. Another species from Zanzibar is *C. kirkii*, in which the hair of the head forms a sort of cap. Ruddy brown hues prevail above, black on the nape and outside of limbs, and white on the under-parts. The other species are from West Africa, and of these *C. satanas* is distinguished by its uniform black coloring, and the shaggy crest on the head. *C. ferruginea*, by its prevailing bay hues, and *C. cristatus*, by its yellowish-brown color and erect, longitudinal crest of hair on the crown.



Simia satyrus, orang-utan.

The generic name *Semnopithecus* is formed in reference to the fact that certain of the species are regarded with great veneration where they occur. This is especially true in the case of *S. entellus*, the Hoonoomaun, or Entellus, which is naturally restricted to the hot tropical plains of the southwest Gangetic provinces, but has been introduced into various other localities by devotees. It is a great nuisance where superstitious veneration for it prevails, and commits great depredations where it is protected. Like the babakoto of Madagascar the hoonoomauns are supposed to be new embodiments of deceased ancestors. The coat is straw-colored, but the hands



FIG. 242.—*Semnopithecus entellus*, hoonoomaun, entellus.

and feet are black, and the outside of the limbs pale chocolate. A full-grown example weighs twenty-two pounds, the body measures twenty-two, the tail thirty-eight inches in length. Most singular in this and other species is the arrangement of the hair of the head, which, indeed, may be employed to distinguish them from each other. In this species the hair of the head radiates from a central spot on the forehead, forming a rounded cap on the crown, but a projecting peak over the eyebrows. The lowest fringe of the latter is of stiff, black hair, but the whiskers and beard agree in color with the rest of the head-dress.

The entellus is replaced in the mountainous districts of Nepal to the north of its

range by the Lungoor, *S. schistaceus*; in the hills of Tipperah to the east by *S. pileatus*. Another beautiful species from Cochin China, is *S. nemæus*, the orange-tinted face of which is surrounded by whiskers of glossy whiteness with a line of chestnut-red over the eyebrows; the fur on the back is of a delicate gray, with a square patch on the loins, the tail and the fore-arms all of a pure white, a gorget of chestnut surmounts the chest; the thighs are black, the legs chestnut-red. Mr. Darwin states his conviction that the beauty and singular arrangement of the colors have been acquired exclusively as ornaments through sexual selection.

Borneo, Java, and Sumatra possess the greatest number of species of *Semnopithecus*. In Borneo are found the Kahau, *S. nasalis*, which has received its specific name on account of its extraordinarily large nose, and *S. rubicundus* with a compressed longitudinal crest of long hair on the crown. Java has the uniformly black *S. maurus* with a wig-like head-covering, and *S. mitratus* of ash-gray color, in which the head-dress is crested and peaked. To the latter is allied the *S. melalophus* of Sumatra, the coat of which is ruddy-colored.

In turning to the lowest forms of the second sub-family, Anthropomorpha, we immediately see united in the gibbons the absence of tail and cheek pouches, and the preponderating length of the anterior limbs which we have noticed as distinguishing all the species from the Cynomorpha. But the gibbons share with these ischial callosities which, however, are small in size. They form the single genus *Hylobates*, which is further characterized by the small, round head, the large orbits, and their almost exclusively arboreal habits. As far as intelligence goes, the gibbons are certainly less well provided with brains than many cynomorphous apes—a statement which is also literally true of one form at any rate, the siamang, in which the hinder lobes of the brain are not at all well developed. The extreme length of their anterior limbs is obviously in adaptation to their arboreal life. The gibbons are social forms, living on fruits and similar vegetable products; they are often noisy, especially the Sumatran siamang, which has a median laryngeal air sac. Another Sumatran species, *H. agilis*, the Wou-Wou, is the only brute which may be said to sing. Its full musical notes range by semi-tones through an octave, and in ascending and descending the scale these are taken perfectly. Darwin says in regard to this species, that after its performance it appears to be much excited, and that it is probably during courtship that it utters its musical sounds.

The gibbons are widely distributed through the eastern peninsula of Asia and some of the larger islands of the eastern Archipelago. The Hoolock, *H. hoolock*, has its headquarters in Assam, and is easily recognized by its coloring, which is black with the exception of a grayish frontal band.

H. lar differs from the hoolock not only in the fact that its hands are white, but also in the whitish yellow frontal band and the white whiskers and beard. It occurs abundantly in groups of eight to twenty, in the forests skirting the hills, which run north and south through Tenasserim, and is found there up to an altitude of three thousand to three thousand five hundred feet; from this it extends south to the straits of Malacca and north as far as northern Pegu.

The Crowned Gibbon, *H. pileatus*, differs from the foregoing in the possession of a white ring around the crown, and in the gray color of the shoulders and loins. It occurs in Siam, but appears to extend to the island of Hainan and even up into the country west of Canton, where, according to Swinhoe, a rock-loving form is found.

The Sumatran gibbons, with the exception of the siamang, which is certainly distinct and is indeed sometimes regarded as the type of a separate genus, *Siamanga*, are probably color-variations of the wou-wou. Black, brown, and gray varieties are known, shading into each other with every possible intermediate color. The Siamang, *H. syndactylus*, receives its specific name from the fact that the second and third toes are united as far as the joint between the second and third phalanges. The dilatable sac of the windpipe is naked in the male, but covered with hair in the female. It is probable that, as is usually the case, the male excels the female in vocal powers.

Of the Anthropomorpha there only remain for consideration the more distinctly man-like apes, — the Orang-utan (*Simia satyrus*), the Chimpanzee (*Troglodytes niger*),



FIG. 243. — *Simia satyrus*, orang-utan.

and the Gorilla (*T. gorilla*). The two latter forms are occasionally referred by naturalists to separate genera, but they certainly resemble each more closely than the orang-utan. In their geographical distribution they are neighbors. It is asserted by Koppenfels that hybrids of the male gorilla and female chimpanzee are not uncommon, and that some of the nominal species are due to them.

Geographically the orang-utan is not a near neighbor of its nearest relatives. It is confined to the forest tracts of swampy lowlands in Borneo and Sumatra, and indeed appears to be rare in the latter. The familiar name for the ape is of Malay origin, and means 'wild man of the woods,' but to the Dyaks the orang is known as the Mias.

The largest specimen, an old male, measured by Wallace, was found to be four feet two inches in height, the outspread arms spanning seven feet eight inches. The

arms are thus very much longer than the legs, the disproportion between them being greater than in any other anthropoid ape. Both hands and feet are long and narrow, the thumbs and great toes are very short, and the fingers and toes are naturally curved, and cannot be placed flat on the ground. The shape of the head is different from that of the gorilla and chimpanzee. Even in old skulls the forehead is rounded, and destitute of those marked ridges which give such a brutal and ferocious aspect to the gorilla. The head itself is pointed and high, the shape of the brain more like that of man than that of the other anthropoid apes. Full projecting lips form the least attractive part of the orang's physiognomy. The face as well as the hands and feet are naked, and the long hair, which is of a red brown color, is scanty except on the limbs and flanks.

Owing to the great length of the arms the hands touch the ground when the orang is erect,—a position which is not assumed, however, unless the animal be on the defensive, or unless it be progressing on the ground and assisting itself along by the aid of overhanging branches. It in fact rarely deserts the trees of the jungles in which it lives. When pressed by thirst the orangs are sometimes found to make their way to water, and Bock reports that they are occasionally caught before they have an opportunity of returning to the jungle. The whole day is spent feeding on fruits and succulent shoots among the trees.

At sundown the orang retires to a nest formed of broken boughs some twenty or thirty feet from the ground, and only leaves it at daybreak. Wallace found that a similar nest was quickly built by a wounded orang, which succeeded very effectually in concealing itself in this way. According to the Dyaks the orangs have few enemies, only crocodiles and pythons; even for these they are a match, so that they are not readily alarmed at the approach of man. Their ordinary pace is from five to six miles an hour, and in this there is no hurry, nor do they jump or spring, but simply swing themselves along by grasping the boughs overhead.

If brought to bay the orang may be a very formidable antagonist, furnished as it is with powerful jaws and teeth; but it generally attempts to save itself by climbing high into the trees, from which broken boughs are cast down on its enemies below.

In captivity the orang does not display the vivacity which characterizes the chimpanzee, but its intelligence is nevertheless superior to that of the lower monkeys, and its ways more man-like.

If we compare the two species of *Troglodytes*, the chimpanzee and gorilla, with the ourang-utan, we shall find abundant evidence of the former being more closely related to each other, anatomically as well as geographically, than they are to the latter. Thus the arms are not so long in proportion to the height, and the size of the fingers and toes as compared with the arms and legs is more nearly the same. Instead of the twelve ribs, and nine wrist bones of the orang there are thirteen and eight, respectively, in the chimpanzee and gorilla. The latter have the thigh-bone connected with its socket by a 'round' ligament, which is absent in the orang. Both the African apes share the strong supra-orbital ridges, and the extension into these of the frontal sinuses. These agreements are not merely superficial but are also found to exist in the vascular and muscular systems.

The Chimpanzee is not only known from the coast of Guinea, but from the heart of Central Africa, and as far north as the Soudan. In such a wide range are many tribes speaking totally different languages, and having, of course, different names for the chimpanzee. Such are N'schigo, M'bouvé, Koola, Baboo, Soko, Quia, Kooloo Kamba.



Troglodytes niger, chimpanzee.

DuChaillu was too ready to suppose that these different names indicated different species, whereas it is now generally conceded that but one species of chimpanzee exists, *Troglodytes niger*, which varies both in form and color within certain limits.

Owing in part to the proportionately shorter trunk, the chimpanzee does not reach the stature recorded for the gorilla. An old male may measure as much as five feet in height, which it will be remembered is considerably taller than the largest orang. But the full height is hardly apparent even when the chimpanzee assumes the erect position, for the natural tendency to all-fours gives a decided forward stoop. This is exaggerated in a favorite attitude in walking, when the legs are bent, but the arms



FIG. 244.—*Troglodytes niger*, chimpanzee.

straightened so that the knuckles rest on the ground. The chimpanzee frequently assumes a sitting position, and the feet then are seen to rest naturally on the outer edges. It is obvious that this direction of the sole of the foot is due to the arboreal habits of the creature, which shows its greatest activity in climbing. The head of the chimpanzee is neither so pointed above as that of the orang nor furnished with such marked ridges as that of the gorilla. Its ears are much larger than in man, the nose projects little from the face, but the mouth and lips are just as ugly as the orang's. The naked skin of the face is a light brownish-yellow, which is darker or blackish in the hands and feet, but in most specimens the neighborhood of the mouth stands out prominently by the presence of scattered white hairs, which may occasionally assume the proportions of a beard. As a whole, the coat is black, formed of thick, shiny hair,

scanty on the under and hinder parts, but abundant and of considerable length on the crown, whence it falls down on each side of the face. Bald specimens are recorded, and many occur in which white hairs are intermingled with the black on the rump, but these disappear in older animals.

The adults associate in pairs, young animals may often be found in groups. Various fruits serve as food, and the cultivated bananas of different tribes are not spared. The natives are anxious enough to get rid of them, even if there were not a market for the live chimpanzees; and thus they are hunted with considerable zeal. Schweinfurth describes how twenty or thirty Niam-Niam hunters will set off on such an expedition, ascend the trees where the chimpanzees are concealed, chase them into snares which have been set for them, and then despatch them with their spears. Unlike the orang the chimpanzee does not retire to a nest at night, except when the female is about to assume the cares of maternity, when the male builds for her, often at thirty feet or more from the ground, a rude nest, of broken and intermixed boughs. Even in the wild state the chimpanzee appears to indulge the instinct of play, which renders it such an attractive inmate of the zoological garden. Savage, the American traveller, to whom we owe the first reliable accounts of the chimpanzee and gorilla, describes how a hollow tree may be used as a drum to call the young ones to play, and how the old folks sit round, keeping watch, and ready to administer a rebuke if deserved. So entirely human are the chimpanzees in their ways, that the natives of certain tribes believe them to be relations which have been degraded from a former higher estate to their present forest life, — an hypothesis of retrograde evolution from an unlooked-for quarter.

Brehm observes of a chimpanzee in captivity, that its bearing is so human that one is constrained to forget the animal side of its nature. It imitates like a child, but does so intelligently and with judgment. In presence of other animals it comports itself with a certain self-importance, founded on the recognition of its intellectual superiority, but it also recognizes its inferiority to man. The chimpanzee referred to, like so many other monkeys, succumbed to inflammation of the lungs, but submitted before death, without a struggle, to the opening of an abscess, evidently understanding that the wound was intended to give relief, and evincing gratitude as soon as it was experienced.

Of all the anthropoid apes the chimpanzee is most frequently to be seen in captivity. The Dresden zoological garden recently possessed a specimen differing from the commonest types in having an entirely black face, a flat, furrowed nose, very strong supra-orbital ridges and narrow hands, as well as in being of greater stature. To indicate this variety one of the native names of the chimpanzee has been called to the aid of science, so that it stands, until further information is obtained, as the Tschego (*T. niger*, var. *tschego*). Whether the tschego may turn out to have its characters sufficiently fixed as to form a good species must be left for future investigation, but some of its distinctive features would be readily accounted for by supposing it to be one of the hybrids between the male gorilla and female chimpanzee.

Some five or six centuries B. C. the Carthaginian admiral, Hanno, made a voyage of discovery along the west coast of Africa, and published an account of his travels, which, in its Greek form, is known as the "Periplus of Hanno." Reference is there made to certain hairy men and women named gorillas, which lived in troops, and employed stones as weapons. Winwood Reade remarks that these were in all probability baboons, as they alone of all monkeys could be so characterized. Dr. Savage,



Troglodytes gorilla, gorilla.

however, who communicated to the Boston Society of Natural History the first reliable account of the Ngina, as it is called by the natives of the Gaboon, commemorated the observation of Hanno by selecting the specific name *Troglodytes gorilla* for this the largest and in some respects the most man-like of the anthropoid apes.

It is possible that the range of the gorilla extends farther into the interior of Africa than has as yet been determined. The habits of the ape cause it to seek the densest and most solitary places in the forest, so that it is more difficult to secure than is the chimpanzee. Schweinfurth gives the delta of the Ogowai river as its headquarters; but it is also found on the Gaboon and Muni rivers; and especially on the Fernand-Vaz.

The gorilla exceeds the chimpanzee in height, old males measuring as much as five feet six or five feet eight inches. The erect position is more readily assumed than in the other anthropoid apes, owing to the shape of the sole of the foot, which is not inverted, and is shorter and broader. This obviously indicates an organization less adapted for climbing than that of the chimpanzee. So, also, the arms of the gorilla are comparatively little longer than in man, and the width of the span of the outstretched arms is in great part due to the extreme breadth of the shoulders, some thirty-six inches in the largest specimens measured. That the gorilla should frequently assume the erect position is not to be wondered at in view of these peculiarities, and we accordingly find it stated that a favorite attitude is that of leaning against a tree. But the tracks show that their ordinary gait is on all fours, and a wounded gorilla at bay will also attack in this position, so that a certain amount of discredit attaches to the tales which represent this monster as savagely beating his breasts with his hands before throwing himself on his victim.

Although the hairy coat of the gorilla is not so long in places as that of the chimpanzee, it is more uniformly distributed, leaving only the face and parts of the hands and feet naked. These parts are of dark bluish-gray color, while the hair itself is very dark gray with a few reddish hairs intermixed.

The physiognomy of this ape is very different from that of the chimpanzee. Instead of its intelligent expression we have here a brutal cast of features due to the extremely prominent supra-orbital ridges and the retreating forehead. These peculiarities become more exaggerated with age, for the young have at first a head which is almost human in its shape. Certain features even in the adult are more human than in the other anthropoid apes. Thus the ears are hardly larger than man's, and the lips are neither so large nor so extensile as in the chimpanzee and orang. The nose is particularly hideous, for it is flattened on the face, and grooved on the surface between the large nostrils. As with other anthropoid apes the proportions of the fingers and toes offer specific characters. The shortness of the gorilla's thumb, the union of the three valuable middle fingers by skin, leaving only the two terminal joints free, the size of the great toe, and the wide angle it forms with the foot, are all worthy of remark.

Du Chaillu asserts that the gorilla is more gregarious than was at first believed, but W. Reade's observations point to a more solitary life. He never saw tracks of more than two gorillas simultaneously. In many respects the habits resemble those of the chimpanzee. A lying-in nest is built for the female by the male, and it is probably that then their life is chiefly arboreal; for the food of the gorilla consists largely of berries which grow on shrubs, of sugar-cane and pisang, which can be obtained in the plantations of the native clearings.

The account of the habits of the gorilla which we owe to Du Chaillu, has at least the merit of being interesting, although it is in certain respects inaccurate. Reade

asserts that a gorilla, old or young, will always attempt to escape from man if it can, but, that like any other animal it will defend itself if wounded and brought to bay. The teeth are probably the chief weapons of defence, although no doubt the powerful anterior limbs may be also employed. When attacked or enraged the excitement of the animal is shown by the erection of the hair on the crown of the head, and of the emission of a powerful roar almost like that of a tiger, which can be heard at considerable distance. The ordinary call is more of a mournful character and unlike the tone of the chimpanzee. That gorillas grow more ferocious with age is readily understood, but that the young are untameable, as was formerly asserted, has now been amply disproved both by observers at the Gaboon, and in Europe. The only gorilla which has been studied in captivity was a young one—a great centre of attraction in Berlin. Pongo's manners were similar to those of the chimpanzee, and there is hardly any doubt that any gorilla caught sufficiently young would be equally tameable.

As the sixth volume of this work is entirely devoted to the discussion of the races of man in every aspect, we merely give here those characters which distinguish Man as a zoological species, *Homo sapiens*, the sole member of the family, HOMINIDÆ.

The most prominent family characters are derived from the distribution of hair on the body, which is, however, subject to wide modifications in the different races; from the fact that locomotion is easiest in the erect posture, owing to the relative shortness of the arms; from the greater length and mobility of the thumb, and the comparative immobility of the great toe. The dentition is $i.\frac{2}{3}$, $c.\frac{1}{1}$, $pm.\frac{2}{3}$, $m.\frac{3}{3}$, there being no gaps or diastemata between the teeth, and no projecting canines. Well-marked skeletal peculiarities are the possession of twelve rib-bearing vertebræ, the rounded skull in which the muscular ridges are a little prominent, and the great capacity of the cranium. This is, of course, in adaptation to the relatively enormous development of the cerebral hemispheres, which much exceed in bulk those of other Primates, and to which man owes his specific name. This is not the place to dwell on the results of the capacity of such an organ, but it will be apparent from the next volume that different races have arrived at different stages of evolution in this respect, as well as in the employment of articulated speech, to which man owes the power of transmitting to others the results of his experience, and his position as the "highest animal."

A few words will suffice to indicate what is known of fossil anthropoids. Forms which appear to have relationships to both groups have been found in early tertiary strata in southern Europe, but in later tertiary periods the differentiation between Old and New World apes is already completed. The present geographical limits were by no means the same then as now, for remains of species of *Macacus*, *Semnopithecus* and *Cercopithecus* are found in pliocene strata of Italy and France. Forms not traceable to existing genera, but bearing relations more or less near to one or another of the Simiadae are found in miocene strata in Europe. Strata of the same age in North America possess forms like *Laopithecus*, indicating relations to the Cebidæ and Limnotheridæ, while Cebidæ proper are only found in the later tertiaries of South America, in many cases representatives of the existing genera.

R. RAMSAY WRIGHT.

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